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FISH DISTRIBUTION AND CENTRAL ASIAN OROGRAPHY

IT has been maintained[1,2] that the Yangtze Kiang basin was upraised 6,000′ to 10,000′ in very recent geological times, similar opinions being advanced by Deprat (not consulted) for Tongking and Eastern Yunnan. These conclusions were supported by lack of any evidence of glaciation, and of canyon formation by the rivers of Yunnan and Western China; but Gregory and Gregory[3] considered these reasons inadequate "for so great an uplift at so recent a date". In their opinion, "Any change in rivers by which their currents become swifter and their fall steeper enables them to wear away their beds. This change may be produced on a high plain by the subsidence of the surrounding country or of deep internal basins." Therefore, "The evidence of the glaciers of Chinese Tibet is rather in favour of a subsidence of the area than of its uplift."

Dr. M. S. Krishnan, Director, Geological Survey of India, from whom I have had much friendly help, favours the possibility of quaternary uplift. "The Middle or Upper Miocene", he informs me, "is thought to be the period of the greatest comprehensive movements, but this actual uplift due to isostatic compensation in the crust took place during the Pliocene or even later. While it is possible that the last uplifts of Central Asia took place in the Pleistocene, we cannot be sure whether a larger part of the elevation was not attained during the Pliocene". He added that as "Parts of Yunnan

and S.-W. China were in a tertiary orogenic belt, there is no reason why the uplift could not be as late as the Pleistocene or Sub-Recent."

There seems to be no way of resolving this controversy without further evidence, which I believe, can be found to a large extent in relevant zoogeographical studies. An analysis of the distribution of the fresh-water fishes of South-East Asia is accordingly presented here as a contribution to this problem. It supports the theory of recent uplift in the regions considered.

Geography of the Fish-Fauna of South-East Asia

The distribution of the fresh-water fishes of South-East Asia[4] suggests that the centre of dispersal of this remarkable fauna can be traced to south-west China, particularly Yunnan. It is so rich and highly diversified that there must have been favourable ecological conditions for it to flourish and speciate. Moreover, as this fauna now extends to Africa in the west, to Ceylon and the Malay Archipelago in the south, to Formosa and the Philippine Islands in the east, and to the Tien Shan Mountains and the Central Asiatic Highlands on the north, the questions of its age and periods of dispersal are of considerable general interest.

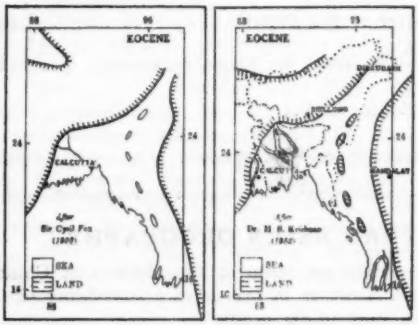

FIG. 1. The Bay of Bengal during Eocene Times

Geographically, it can be divided broadly into two groups: the trans-Himalayan fauna and the cis-Himalayan fauna. Day,[5] Stewart,[6] and Hora[7] have shown that there is no noteworthy similarity between the fish-faunas of the northern and southern faces of the Himalayas: a few forms characteristic of the Asian Highland are found to the south of the Himalayas, but none of the typical southern forms is found in the trans-Himalayan areas of the region. Of course, according to our present taxonomic knowledge, allied or identical genera are found in both the regions, but they look very different from one another and need more critical evaluation.

Tertiary Barriers to Dispersal

Geologists tell us that during the Eocene and Miocene periods there was an arm of the sea separating India from Burma (Figs. 1, 2),

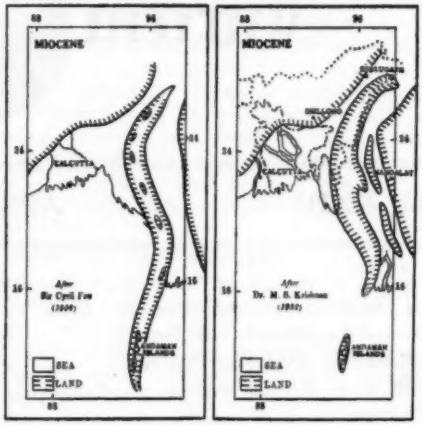

FIG. 2. The Bay of Bengal during Miocene Times

though Dr. M. S. Krishnan informs me that there is no evidence that "the Mishmi Hills region (E and NE of Sadiya) was under the sea at all in the Upper Tertiary, even if we take it that the Tethys extended over it and into Burma up to the end of the Eocene". Even so, the dispersal of fresh-water fishes from Yunnan to India could not have been possible during these periods, and there is no contrary palæontological evidence.

The climate during these periods was probably temperate and equable, for the hot and moist winds from the south could then blow through the gap and over the northern regions. Dr. S. K. Banerji (former Director-General of Observatories, India), supports this view. After analysing the geological evidence, he informed me that: "Our present arctic regions were, during Eocene times, in about Lat. 45° N., and the lower part of the Archiboreis (Asiatic Block) was on the equator. The low pressure system during summer was apparently in the central part of this block, which caused an air-drift from the Thetis, as well as from the Pacific Ocean. At this time Yunnan was much nearer the equator than it is at present. The statement that hot and moist winds from the Tethys rendered the climate temperate and equable thus appears to be reasonably correct."

The effects of such a climate need little comment. In general they are conducive to the maintenance and gradual spread of animal species, but they do not enlarge the biological conditions and pressures that provoke migrations. This is especially true of fresh-water fishes.

The Beginnings of Dispersal

In the Pliocene the picture changes (Fig. 3). The major upheaval of the Himalayas, which

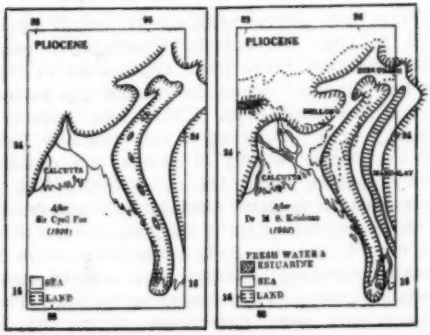

FIG. 3. The Bay of Bengal during Pliocene Times

seems to have occurred towards the close of the Miocene, or early in the Pliocene, probably rendered the arm of the sea shallow and may have cut it up into brackish water lakes and lagoons. With the advance of time, and concomitant with the Himalayan uplift movements, marshy conditions corresponding to those of the Siwaliks seem to have been established in this area.

Marsh-loving and sluggish-water fishes could now migrate to India. We know definitely that they did so from the occurrence of Bagrid fishes of the genera *Chrysichthys*, *Mystus* and *Rita*, Clariids[8] of the genera *Clarias* and *Heterobranchus*, and various *Ophicephalids*, in the Siwalik rocks of India.

Low hills also made their appearance in the Pliocene. This is indicated by the occurrence of *Bagarius*, a characteristic hill-stream catfish of the family Sissoridæ, in the Siwalik formations. It is found in south-west China, and is clearly a migrant from the Malayan region, where it is known from the tertiary deposits of the highlands of Padang in Sumatra.

The Pliocene climate of the Central Asian region, particularly south-west China, remained temperate and equable, while the area it affected was flat and fairly low. This can be inferred from the topography of the area between south-west China and India (Fig. 3) at that time, as well as the ecological requirements of the fishes that then migrated to India: in fact, the nature of these fishes suggests that the climatic and topographical conditions of the period were somewhat similar to those now prevailing in Bengal.

It follows that the totality of the influencing Pliocene circumstances produced new environmental dynamics favourable to the migration of many species, but the westwards dispersal of the remarkably adapted torrential fishes is a much later phenomenon.

Pleistocene Conditions and Fish Dispersal

There is abundant geological evidence that there was another major uplift of the Himalayas after the Pliocene. Therefore, the closing of the marine, estuarine and marshy gap between India and the countries to the east and north must have taken place during the Pleistocene.

The effect of this upheaval on the monsoons, which have an evident bearing on the ecology of fresh-water fishes, also concerns our argument. For the monsoons, as we know them in India to-day, could not have been established till their passage to the Central Asiatic region had been blocked by a mountainous barrier in the north-east; and Central Asia would accordingly have remained wetter and more favourable to fish-life than it is now.

Meteorological confirmation of this point again comes from Dr. S. K. Banerji, who writes (*in litt.*) that "The south-west monsoon in its present form apparently commenced to be established at the close of the Würm glaciation, that is about 20,000 years ago. But the temperature conditions that prevailed 10,000 years ago, as deduced from Milancovitch's curves, would strongly support your argument about the comparatively recent dispersal of fishes along the Western Himalayas". He also stated that the present monsoon system must have developed when the Himalayas attained a height of 10,000′ to 15,000′, which is roughly the depth of the south-west monsoon current.

Moreover, during the Pleistocene, there was periodic refrigeration and five periods of glaciation,[9] each one of which lasted several thousand years. In the Western Himalayas (Kangra Valley), according to Wadia,[10] the glaciers seem to have descended below 3,000′. In the Eastern Himalayas (Sikkim and Naga Hills), Blanford[11] recorded moraines, on the evidence of W. T. Blanford and H. H. Godwin-Austen, from elevations of 6,000′ and 4,500′.

Consequently, the fish-fauna, if any, of the southern slopes of the Himalayas must have

been exterminated at higher altitudes during the glacial periods. Only a few forms, which have been either introduced or have means of migration, are now found at higher elevations, though fishes are found in some abundance and variety at lower elevations. The lakes and rivers of Central Asia, on the other hand, support a uniform but fairly rich fish-fauna, which seems to have escaped all the periods of Pleistocene glaciation or intense refrigeration. Their survival strengthens the view that the Central Asian region was at a quite low level even during the last glacial phase, and that its uplift took place during the last 10,000 to 15,000 years. The Central Asian fish-fauna is thus an antecedent fauna so far as the recent uplift is concerned.

The Evidence of the Schizothoracine Fishes

This assumption gains from the fact that the remains of typical Central Asiatic Schizothoracine fishes have been found in the Karewas of Kashmir.[12] According to de Terra,[13] the remains of the Schizothoracine fishes came from an exposure of Lower Karewa beds of the first interglacial period (approximately 560,000 to 500,000 years ago), which indicates the differentiation of the Central Asian fish-fauna about the middle of the Pleistocene. It should be noted, too, that the Karewa fossils were laid down in the bed of a lake or sluggish river at a much lower elevation; and were, as Sahni[14] writes, "*lifted out* of their original horizontal position and upheaved through at least 5,000' with the (geologically speaking) recent upheaval of the Pir Panjal Range".

The first glacial period, through eustatic changes in the sea-level,[15] seems to have produced a false uplift of a few hundred feet, thereby increasing torrential conditions in the streams of the young Himalayas and the adjoining regions. During this period, the Schizothoracine fishes seem not only to have spread along the northern face of the Himalayas, but a representative of the primitive stock also crossed the flat strip between the Garo and Rajmahal Hills, which we call the Garo-Rajmahal Gap. It came down the Western Ghats to the Periyar Lake of Travancore, where it developed, through isolation, into a new genus recognisably descended from its *Schizothorax*-like ancestor. Sundara Raj[16] gave the fish providing this remarkable case of discontinuous distribution the name *Lepidopygopsis typus*; and pointed out that it occupies an intermediate position between the primitive and nearly related genera *Paratylognathus*[17] and *Schizothorax*, and such specialised genera as *Schizopygopsis* and *Gymnocypris*.

The differentiation of *Lepidopygopsis* can be simply explained. The primitive Schizothoracine stock that migrated to Peninsular India during the first glacial period had ample time to diverge from the stock that remained in Central Asia, particularly since the streams of the Peninsula were rejuvenated during the Pleistocene owing to a west-to-east tilt not amounting to actual uplift.[18]

Conclusions and Implications

From the above evidence it would appear that in bulk the modern Ostariophysi (carps and catfishes) made their appearance in India in the Pliocene,* when the marine gap between India and south-west China had become a marshy area. *Bagarius*, a fish normally living in the deeper waters of rapids and cascades, also appeared about the same time; but the Schizothoracinæ came later and did not become widely distributed until the first glacial period of the Pleistocene. Fishes characteristic of the smaller torrential streams have a more or less parallel history of emergence in the early Pleistocene and wide distribution during its first glacial period, their present occurrence at lower elevations throughout their range being suggestive of their evolution in, and dispersal through, streams at lower altitudes. Radial dispersal of this remarkable fauna from Yunnan strongly favours the theory that this area was uplifted in geologically recent times.

The acceptance of this view involves some interesting general implications. For example, it would place the migration of the supposedly Aryan pre-historic peoples inhabiting the plateau of Central Asia somewhere between 7,500 and 10,000 years ago, because the last glaciation, which commenced about 18,000 years before the beginning of the Christian era, seems to have lasted for nearly 10,000 years. The Central Asian region must have been at a low level during this last glacial period, thereby permitting the survival of its fish-fauna and human populations.

Finally, the major evolutionary thesis prompted by the orographic history of the regions considered is that the relatively recent uplifts pro-

* I have recorded, *Rec. Geol. Surv. India*, 1938, **73**, 267-94, an incomplete Cyprinid scale from the Inter-Trappean beds of Deothan and Kheri, but was not able to assign to it any generic position. It is probable that early in the Eocene Cyprinoid fishes entered India through the then existing Cretaceous land bridge between India and China.

vided a dynamic environment conducive to migration, isolation and rapid speciation. The rich and very diverse fauna and flora of south-east Asia becomes more understandable in the light of this theory. Particular studies have accordingly been designed, with encouraging results, to prove its validity; but their discussion belongs to another and later synthesis.

Zool. Survey of India, Calcutta. SUNDER LAL HORA.

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PREDICTION OF ELECTRONIC FAILURES

A RELATIVELY unexplored approach to the problem of insuring higher reliability of electronic equipment is being investigated at the National Bureau of Standards, U.S.A. A technique has been evolved experimentally in which a maintenance man simply plugs a portable failure-prediction unit into the slightly modified equipment to be checked and turns a multi-point selector switch; a red light flashes on to identify stages or components that have deteriorated below safe levels and have become prospective causes of equipment failure.

Failure of electronic equipment to function properly may be caused either by sudden or by gradual failure of a tube or other component. Although improvement of quality seems to be the only way to reduce sudden failures of components, surveys have indicated that at least half of all equipment failures are produced by gradual deterioration of components. The NBS work has been concerned with practical means of spotting these gradual failures before the equipment becomes inoperative. The success of the experimental work at NBS suggests that provision for simple failure-prediction routines for the maintenance of important electronic equipment deserves the serious attention of design engineers.

COBALT 60 TO REPLACE RADIUM FOR CANCER THERAPY

A COBALT 60-beam therapy unit, a gift to Britain from Canada, is shortly to be installed at Mount Vernon Hospital, Northwood, Middlesex. The unit is described as being 200 times more powerful than the radium units in use at present. It is more stable, more reliable and simpler to control than super-voltage X-ray machines and might prove more effective in the control of cancer. It is expected to treat deep-seated, internal, inaccessible tumours which so far have proved beyond the effective range of existing apparatus. A further advantage of the unit is that a greater quantity of radiation could be delivered to the tumour with less damage to the surrounding normal tissues and less disturbance to the general state of the patient.

Cobalt 60 is produced by the exposure of natural cobalt in the nuclear reactor or atomic pile. It is particularly suitable as a substitute for radium in some methods of application. The cobalt itself is relatively cheap and readily obtainable. The cobalt 60 source in the units is a disk only 1" in diameter and ½" thick. The beam of radiation could be compared in penetrative power to that produced by an X-ray machine working at three million volts. The cobalt 60 deteriorates to half its original intensity in just over five years, and it is, therefore, necessary to arrange for reactivation in a nuclear reactor at regular intervals. The cost of a radium unit of such activity would be well over one million pounds, as compared with a cost of £ 25,000 of the cobalt unit.

THE SEVERE NAGAPATTINAM CYCLONE OF 30th NOVEMBER 1952

P. R. KRISHNA RAO AND S. N. SEN
Regional Meteorological Centre, Madras

A SEVERE cyclone from the south Bay of Bengal struck the south Tamilnad coast between Nagapattinam and Point Calimere on the afternoon of the 30th November 1952. It caused widespread devastation in the Tanjore District and the adojoining areas of Tiruchirapalli District. About 400 human lives and thousands of livestock are reported to have been lost as a result of the cyclone. High winds which reached hurricane force or more in the inner core of the cyclone uprooted a large number of trees, severely damaged many huts and buildings and destroyed thousands of acres of plantations and gardens. It also caused widespread disruption and dislocation of road, rail, telegraph and other communications in the area. A storm wave swept inland to a distance of 2-5 miles along the coast to the north of the cyclone centre up to Nagapattinam, due to the onshore easterly hurricane winds, causing considerable damage to crops and property. As the coast line running north to south turns sharply at Point Calimere to the west to a distance of about 30 miles, this east-west coastal region experienced a storm wave from the south caused by the southerly hurricane winds after the cyclone had just crossed the coast. The cyclone fortunately struck the coast in the daytime at a time of low tide. Otherwise, the storm wave would have caused greater flooding and the damage would have been very much more extensive than it was.

The cyclone originated as a depression in the south Bay of Bengal on the night of the 27th November 1952. It moved west-north-west and intensified rapidly into a severe cyclone which was centred about 500 miles to the east-south-east of Nagapattinam on the morning of the 28th and about 300 miles east-south-east of Nagapattinam on the morning of the 29th. It continued to move west-north-west and was centred about 100 miles due east/east-south-west of Nagapattinam on the morning of the 30th. Moving westwards later, it struck the coast at latitude 10° 30′ N. about 10 miles to the north of Point Calimere and about 20 miles to the south of Nagapattinam on the afternoon of the 30th at about 1-30 p.m. The cyclone moved at an average speed of about 10 m.p.h. up to the morning of the 30th and at a somewhat faster speed (about 12 m.p.h.) later. It weakened after crossing the coast and moved rapidly westwards as a depression. On the morning of the 1st December, it lay as a low pressure area over the East Arabian Sea off the Malabar Coast. The track of the cyclone is shown in Fig. 1.

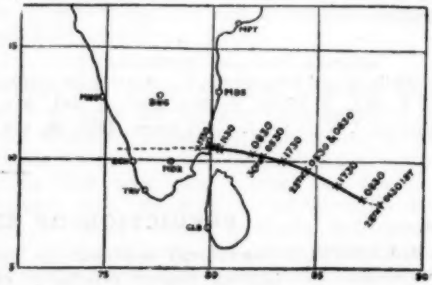

FIG. 1. Track of Nagapattinam Cyclone, November 1952.

WEATHER REPORTS FROM SHIPS

Reports from *S.S. Worcestershire* (which was sailing from Rangoon to Colombo) on the night of 27th-28th November 1952 gave the first definite indication of the development of the depression. At 0100 G.M.T. of 28th, the ship reported 50 knots (55 m.p.h.) easterly wind with moderate continuous rain at latitude 8° 56′ N., longitude 87° 30′ E., about 60 miles north of the cyclone centre. The lowest pressure recorded in the ship was 990·8 mb. at 2245 G.M.T. of 27th when wind was NE/E, 50 knots, with very rough sea and very heavy swell.

S. S. Jalagopal, which left Nagapattinam for Penang on the early morning of the 28th with 1,600 passengers on board, experienced very severe weather in the south-west quadrant of the cyclone on the night of the 28th-29th. She was about 200 miles to the west of the cyclone centre on the 28th evening and about 150 miles to the south on the early morning of the 29th. At 1016 G.M.T. (1546 I.S.T.) on the 28th, the ship which had changed to a south-east course reported at latitude 8° 53′ N., longitude 83° 39′ E., north-west wind, speed 36 knots gusting 45 knots frequently, with continuous heavy rain and visibility half a mile. Barometric pressure was falling steadily, the fall in the previous 3 hours being 3·4 mb. There was a north-westerly swell with period of waves 12 to 13 seconds and height of waves 15′ to 20′. On the 29th morning (00 G.M.T.) when the ship was

at latitude 7° 20′ N. and longitude 84° 48′ E. on a south-south-east course, she reported wind W by N, 50 knots, gusting to hurricane force all night, with continuous heavy rain, visibility nil, heavy sea wth west-north-westerly heavy swell and mean height of waves 25′ to 30′. Barometric pressure was 1006·8 mb. and had been falling steadily in the previous 3 hours. The ship was labouring heavily with a maximum roll of 33°. The Captain of the ship who was interviewed later at Madras stated that extremely rough weather with mountainous seas was experienced on the night of the 28th-29th from 9 p.m. to 6 a.m. as the ship was sailing on a south-south-east course to avoid the cyclone. The ship had a miraculous escape with only a slight damage.

S. S. Clan Mactavish, which left Madras on the 29th evening for Colombo, was hardly 50 miles to the north of the storm centre when she reported at 0400 G.M.T. of 30th at latitude 11° 16′ N., longitude 80° 54′ E., easterly wind, force 11 (about 70 m.p.h.), high sea and swell and barometric pressure 993·8 mb.

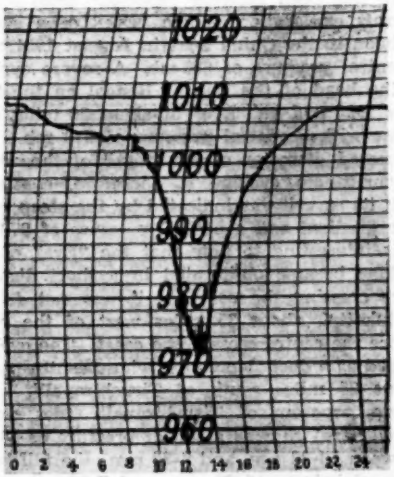

FIG. 2. Barogram of Nagapattinam, 30th Nov. 1952.

Weather at Nagapattinam

The weather at Nagapattinam was overcast with low clouds and raining from the midnight of the 29th and 2″ of rain occurred up to 0730 a.m. of 30th. The wind was N. to NE. By 10 a.m. the wind increased to force 6-7 (30 m.p.h.) still from north to north-east and sky was overcast with driving rain. Sea when visible was very confused with mountainous waves. By 11 a.m. wind was gale force 9 (50 m.p.h.) and from then onwards it increased to hurricane force, still from the north-east. At about 1 p.m. it veered to east and according to the report of the local Port Officer the storm was at its climax at about 1-30 p.m. when the port was struck by a storm wave of great force which was estimated to be about 4′ in height. The storm wave caused much damage in and around the port. At about 2-30 p.m., the wind veered to south-east and continued to blow with hurricane force until about 4-30 p.m. when it showed signs of abating. By 1800 hours the wind had become moderate and the sky had cleared considerably. Nagapattinam Observatory measured a wind speed of 50 m.p.h. at 1130 hours on the 30th after which the wind instrument got damaged.

Barogram of Nagapattinam

The barogram of Nagapattinam Observatory reproduced in Fig. 2 reveals some very interesting features about the cyclone. The lowest pressure reached was about 970 mb. at about 1-30 p.m. on the 30th. This was about 40 mb. below the pressure 24 hours earlier which was about the normal pressure. The pressure began falling rapidly from 10 a.m. and fell by 29 mb. from 999 to 970 mb. in about 3 hours' time. The most rapid fall of pressure was 14 mb. from 11-30 a.m. to 12-40 p.m., a period of 1 hour and 10 minutes, which works out to a rate of fall of 12 mb. per hour. With the estimated speed of movement of the cyclone, *viz.*, 12 m.p.h., the steepest pressure gradient in the inner area of the cyclone, as it passed Nagapattinam, works out to 1 millibar per mile. This was at a distance of about 20 miles from the centre. The gradient of 1 mb. per mile agrees with the average pressure gradient in typhoons with minimum pressure of 960 to 973 mb. given by Deppermann.[1] The steepest rate of pressure fall on record at the centre of an Indian cyclone was 25 mb. per hour in the False Point cyclone[2] of 5th November 1891 which had the lowest pressure of 949 mb. With a speed of movement of 10 m.p.h., the steepest pressure gradient in that cyclone works out to 2·5 mb. per mile, while in the present Nagapattinam cyclone it is estimated to be 1 mb. per mile at a distance of 20 miles from the centre and about 10 miles from the periphery of the "Eye".

Another interesting feature shown by the Nagapattinam barogram is the rapid fluctuation of pressure at the time of minimum pressure exhibiting pronounced "pumping" over the central region of the cylone. The maximum amplitude of the fluctuations was as large as 7 mb., the pressure fluctuating between 970 and 977 mb.

The Eye of the Cyclone

The Nagapattinam cyclone had a pronounced *Eye* or calm centre as should be expected in a cyclone with such steep pressure gradient. In this connection, a summary of weather at Point Calimere reported by the Keeper-in-Charge of the Light House there is given below :—

> "On the whole day of the 29th November, the sky was almost clear with some passing clouds. There was no rain. The wind direction was NE. Towards midnight the sky began to overcast with heavy clouds and very chilly NW wind. This continued until 7 a.m. of 30th with intermittent drizzling. After that, the force of the wind and rainfall increased gradually. At 9 a.m. the wind from the same direction increased to gale force mingled with moderate rain. This lasted up to 1 p.m. After that, the wind and rain suddenly stopped ; sky began to clear with bright sunshine. The air was *dead calm*. Suddenly at about 1-45 p.m. some rumbling noise resembling distant approaching train was heard from south with whitish high waves in the sea. At 1-45 p.m. the wind at a force of about 75 to 80 miles an hour struck the coast from the south. The trees and roofs of the building began to fall down on the first impact itself. This lasted up to 4 p.m. and then onwards the force of wind decreased gradually. During the period of the cyclone there was very little rain in our part and should, in my estimate, be under 2" on the whole."

Mr. S. Gasper of the Regional Meteorological Centre, Madras, who visited the cyclone-affected areas, gathered information of similar experience of "Calm" conditions for sometime in the midst of the cyclone at Tiruthuraipundi, about 20 miles to the south-south-west of Nagapattinam and 22 miles to the north-west of Point Calimere, and also at Vedaranyam, about 6 miles to the north of Point Calimere. The Tahsildar at Tiruthuraipundi had recorded that heavy rains and northerly gales commenced at 0900 I.S.T. on the 30th and continued uninterrupted till 1415 hours. Thereafter, there was sudden cessation of rain and wind but the sky remained overcast. After about an hour of calm condition, hurricane winds recommenced from the opposite direction with heavy rain. At Vedaranyam, the Deputy Tahsildar had recorded similar observation with the difference that the lull in weather commenced at 1300 hours and lasted for about 45 minutes. Nagapattinam did not experience any calm condition or reversal of wind direction. The Eye did not, therefore, pass through Nagapattinam.

The calm condition commenced at 1300 hours at Point Calimere and Vedaranyam and at 1415 hours at Tiruthuraipundi. Considering that the cyclone moved due west across the coast and that Tiruthuraipundi is about 15 miles due west of the coast, the approximate speed of movement of the cyclone works out to be 12 m.p.h., agreeing with the speed estimated from the positions of the cyclone centre as located on the synoptic weather charts. As the duration of the calm over Point Calimere was about 45 minutes, it means that a chord of about 9 miles of the "Eye" passed over that station. Similarly, a 12-mile chord passed over Tiruthuraipundi. On this basis, the position of the "Eye" at the time of the cyclone centre crossing the coast is indicated in Fig. 3. Assuming the Eye to be circular, its diameter works out to be about 20 miles. Even though the average diameter of the "Eye" of tropical cyclones is believed to be 10-15 miles, "Eyes" having diameters of 20-30 miles have also been observed in intense storms. A diameter of 40 miles has been recently reported[3] from actual aircraft exploration of the "Eye" of a severe typhoon in the China Seas in August 1951 with a central pressure of 895 mb. A severe cyclone at the head of the Bay of Bengal on the 27th May 1936 had an "Eye" of about 20 miles diameter with a central pressure of 979 mb. The estimated diameter of the "Eye" of the recent Nagapattinam cyclone is, therefore, consistent with its severity as indicated by the steep pressure gradient and a central pressure of 970 mb. It is interesting to note that the "Eye" of the cyclone became obliterated in a short distance after crossing the coast as it was not felt at Pattukottai, about 35 miles west of the point where the centre crossed the coast. The cyclone moved as a deep depression whose centre passed about 25 miles south of Tiruchirapalli. The micro-barogram of Tiruchirapalli (not reproduced here) showed a fall of pressure of 18 mb. between 10-30 a.m. and 7-30 p.m., the fall being steepest between 5-30 p.m. and 7-30 p.m. The lowest pressure recorded at Tiruchirapalli was 979 mb. at 7-30 p.m.

Winds in the Cyclone

The cyclone was a very severe and concentrated one with a comparatively small core of hurricane winds around the calm centre ("Eye") Nagapattinam had hurricane winds for about 5½ hours from 11 a.m. to 4-30 p.m. Assuming that the core of hurricane winds was circular

and the speed of movement of the cyclone was 12 m.p.h. when it struck the coast, a chord 66 miles ($12 \times 5\frac{1}{2}$) long of the inner core must have passed through Nagapattinam. From this, it is estimated that the radius of the core of hurricane winds was about 38 miles. As the radius of the "Eye" was about 10 miles, the annulas of hurricane winds around the "Eye" was about 30 miles wide. The diameter of the core of hurricane winds including the "Eye" was therefore about 80 miles. The extent of the core is also shown in Fig. 3.

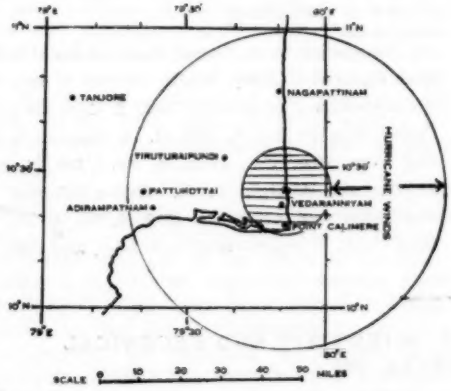

FIG. 3. Dimensions of the 'Eye' (Hatched Circle) and Region of Hurricane Winds at the time of Cyclone Crossing the Coast.

The highest wind speed reached in the cyclone can only be estimated indirectly as there was no instrumental record. From the severe nature of the damage caused, viz., bending of telegraph poles, uprooting of big trees, snapping of the trunks of trees of 4' to 5' diameters, shaking and collapses of strong buildings and roofs, etc., it has been estimated by some that wind speed may have reached 150 m.p.h. in gusts, while the lowest estimate is 80 to 90 m.p.h. From the very steep pressure gradient and the magnitude of the pumping of the barometric pressure at Nagapattinam as indicated by the barogram, it would appear that the wind must have reached a speed of over 100 m.p.h. and 150 m.p.h. in gusts may not be an overestimate. In the Masulipatam Cyclone of October 1949[4] in which the central pressure was 977 mb. and the pressure gradient in the core of hurricane winds as estimated from Masulipatam barogram was only 1 mb. in 51 miles, an estimated wind speed of about 100 m.p.h. was reached. It should be remarked that the area of hurricane winds need not necessarily be circular. In fact, it is known[5] that in westward-moving tropical cyclones in the northern hemisphere, gales and hurricanes extend further to the north than to the south, which appears to have been the case in the Nagapattinam cyclone. The area of gales extended up to Madras, about 200 miles to the north of the centre. Towards the south, however, gales were experienced at Jaffna about 80 miles to the south of the cyclone centre, but not at Pamban, about 120 miles to the south-south-west. Tiruchirapalli, situated about 80 miles to the west of Nagapattinam, experienced gales after 3 p.m. and the strongest winds, about 50 to 60 m.p.h., were experienced at 7 p.m. to 8 p.m.

Air Masses Involved in the Cyclone

It is seen from the weather charts that the Nagapattinam cyclone originated as a depression in the south Bay on the inter-tropical front between Tropical Maritime (Tm) and Equatorial Maritime (Em) air. The Tm air was, however, conspicuously weak throughout the period of the cyclone. This cyclone apparently provides another instance of formation of a depression by the interaction of two air masses and of its rapid intensification with the development of a "Triple Point" when the depression moved westwards into the field of the Tropical Continental (Tc) current. There was clear indication that there was appreciable strengthening of northerly Tc air over the entire peninsula prior to the cyclone approaching the coast. There being no strengthening of the Tm air, Tm-Tc warm front or discontinuity was weak or inactive and the air masses involved in the cyclone were mainly Em and Tc. As such, the distribution of rainfall in this cyclone was somewhat like that in the south-west monsoon cyclones with the heavy rain in the south-west quadrant of the storm. Heavy rain exceeding 6" was reported by a number of stations within a belt of about 12 miles to the south of the storm track during the 24 hours ending 0830 hours I.S.T. of 1st December, principal amounts being Agastiyampalli (near Point Calimere) 9·1" and Alangudi 15·0". The lack of Tm air appears to have been responsible for the comparatively less rainfall to the north of the storm track and also for the short spell of heavy rain caused by this cyclone.

Previous Severe Cyclones which Struck near Nagapattinam

Examination of past records shows that in the last 62 years (1891-1952), 6 cyclones have

struck the coast near Nagapattinam in the north-east monsoon season October-December. Of these, 3 cyclones in November 1935, November 1939 and November 1952, have been severe. The severe cyclone of November 1935 had a track almost identical with that of the November 1952 cyclone. It struck the coast just to the south of Nagapattinam in the early hours of the 15th November 1935 and lay as a deep depression near Tiruchirapalli on the morning of the 15th. Thereafter, it moved rapidly westwards into the Arabian Sea by the next morning. It caused widespread heavy rain in south-east Madras where railway and other communications were considerably dislocated. Nagapattinam suffered considerable damage and thousands of trees were uprooted in the coastal districts. "*The Hindu*" of 19th November 1935 stated that "the storm which swept over Vedaranyam and Agastyampalli and Point Calimere on the 14th instant was one of the severest that was ever experienced within the last 40 years and it has played great havoc in this part of the country resulting in the loss of human lives and countless cattle and damage to a thousand houses". Both the 1935 and 1939 cyclones were very much less deep and had less steep pressure gradients than the 1952 one, but caused more rain. A comparison of the structure and movement of these two previous Nagapattinam cyclones and of the Masulipatam cyclone of October 1949 with the present one is expected to reveal some interesting features.

A detailed technical study is being made and it is intended to publish the results in a paper in the *Indian Journal of Meteorology and Geophysics* in due course.

1. Deppermann, C. E., "Some characteristics of Philippine Typhoons" (1939), Manila—referred to on p. 88, of *Compendium of Meteorology*, 1952. 2. Eliot, Sir John, *Cyclone Memoirs*, No. V, 1893, 81. 3. Simpson, R. H., *Bull. Amer. Mete. Soc.*, 1952, **33**, No. 7, 286. 4. Sen, S. N. and George, C. A., *Indian Journal of Meteorology and Geophysics*, 1952, **3**, No. 4, 264. 5. Dunn, G. E., *Compendium of Meteorology*, 1952, 889.

FORTHCOMING INTERNATIONAL SCIENTIFIC AND TECHNICAL CONFERENCES, 1953

	Date	Subject	Organized by	Location
1	June 16–24	International Union of Pure and Applied Physics—Congress on Acoustics.	Prof. Kosten, Mijnbouwplein 11, Delft, Netherlands	The Hague, Delft, Hilversum and Eindhoven
2	June 21–25	Institute of Food Technologists—13th Annual Meeting.	The Secretary, University of Massachusetts, Amherst, Mass.- U.S.A.	Boston, Mass.
3	June 24–26	Organisation for the Advancement of Spectrographic Methods—16th Congress	Secretariat, 1 Place Saint Thomas d'Aquin, Paris	Paris
4	June 24–26	Colloquium on the Study of Water Molecules in Solids by Electromagnetic Waves	Secy., Centre Nationale de la Recherche Scientifique, 13, Quai Anatole, Paris	Paris
5	July 5–11	International Union of Pure and Applied Physics—Colloquium on Cosmic Rays	Prof. L. Leprince-Ringuet, 17, rue Descartes, Paris	Bagneres-de-Bigorre, France
6	July 13–18	International Astronomical Union-Symposium on Gas Dynamics of Interstellar Clouds	General Secy., Mr. P. Th. Oosterhoff, Leiden Observatory, Netherlands.	Cambridge, England
7	July 14–25	6th International Congress of Radiobiology	Secy.-General, Prof. Flemming Norgaard, Oster Voldgade 10, Copenhagen K, Denmark	Copenhagen
8	July 22–25	International Astronomical Union—Symposium on co-ordination of Galactic Research	General Secy. Mr. P. Th. Oosterhoff, Leiden Observatory, Netherlands	Groningen, Netherlands
9	July 29-Aug. 4	International Union of Pure and Applied Chemistry—17th Conference and 13th Congress of Physical Chemistry—Wood and Paper Chemistry	Secretaire-General, 4, Aveune de l'Observatoire, Paris 6	Stockholm

ON COLD POOLS AND THEIR ROLE IN THE DEVELOPMENT OF NOR'WESTERS OVER WEST BENGAL AND EASTERN PAKISTAN

C. RAMASWAMY AND B. L. BOSE
Meteorological Office, Calcutta Air Port

DURING the pre-monsoon period, March to May, West Bengal and Eastern Pakistan and the adjoining areas are visited by thunderstorms of a severe type which are popularly known as nor'westers and which sometimes reach tornadic violence, causing heavy destruction of life and property. The mechanism of these thunderstorms has been investigated by a large number of meteorologists,[1-14] but it is yet very imperfectly understood. Consequently, even to-day, the forecasting of nor'westers continues to be one of the most baffling problems in Indian Meteorology and the forecaster has often to fall back upon empirical methods for issuing timely warning against these thunderstorms.

It is clear from a perusal of the literature so far published on this subject that emphasis has been laid by most of the workers on the sea-level conditions and in the layers of the atmosphere below 10,000', especially between 3,000' and 5,000' where there is a marked inversion caused by the dry northwesterly winds (Tc) over-running the relatively colder and moist southerly winds (Tm) from the Bay of Bengal. As early as in 1937, however, Ramanathan and Ramakrishnan[11] pointed out that, in addition to the breaking down of the inversion, which is a fairly regular feature in the afternoons even on days of no nor'westers, the replacement of the normally warmer air over Bengal at 20,000' and aloft by colder air, would be necessary for the development of these thunderstorms. Their remarks were, however, of a general nature based on *average monthly temperatures* and *not on a study of individual cases*. This aspect of the problem subsequently received little attention by the later workers in this field, presumably because of the lack of sufficient upper air temperature data to confirm or contradict the views expressed by Ramanathan and Ramkrishnan.

The present authors have pursued this aspect of the problem by a study of the thickness patterns at the 700 and 500 mb. levels over north-east India and Eastern Pakistan during the nor'wester season. Seven spells of extensive nor'wester activity have been studied by this method.* Six of these spells related to the nor'wester season of 1952 and one related to 7-3-49. The last-mentioned case was specially chosen because it was responsible for a record squall of 76 m.p.h. at the Calcutta Airport although there were very few indications in the charts for sea-level or upper levels below 10,000' to suggest the development of a nor'wester of this severity. Among the six spells in 1952, the one on 14-4-52 was also specially selected because it caused a severe squall at Calcutta in the afternoon from the east—a very unusual direction—for as long a period as one hour and blew away the revolving beacon from the terrace of the Control Building at the Calcutta Airport. In this case also, practically none of the conditions usually associated with nor'westers existed either at sea-level or anywhere below 10,000' a.s.l.

The thickness patterns at 700 mb. (1,000 – 700 mb.) and at 500 mb. (700 – 500 mb.) were drawn on the basis of the thermal winds and thickness values at these levels. The thermal winds were computed from the Pilot Balloon winds for 09 G.M.T. available for a large number of stations in India, Eastern Pakistan and Burma. The thicknesses were obtained from the Radiosonde data of 15 G.M.T. of the Radiosonde stations in India and Western Pakistan (total 12 in number).

A study of the seven cases† referred to above has revealed the following:

(a) In every one of the seven cases, 18-24 hours before the outbreak of the nor'westers, there was either a cold pool (i.e., an area where there was at least one closed thickness line curving cyclonically) or a well-marked cold trough (i.e. an area in which the thickness lines were symmetrical and curved cyclonically) at the 500 mb. level in the area where the nor'westers developed. This time-difference between the first appearance of the cold pool (or cold trough) and the later development of nor'westers is of special importance in view of its usefulness in forecasting.

* Mr. C. K. M. Douglas[15] and others have studied the significance of thickness patterns in the development of thunderstorms in middle latitudes. As far as the present authors are aware, a similar study has so far not been made with regard to thunderstorm-situations in India and Pakistan.

† These conclusions have been confirmed by one more case of extensive and severe nor'westers, *viz.*, on 18-4-1944.

(b) The nor'westers tended to be a maximum in the sector of the cold pool or the cold trough where the thermal winds were between SSE and WSW.

(c) In six out of the seven cases, in the region where the thermal winds were between SSE and WSW, the actual winds had an appreciably greater westerly component than the thermal winds suggesting the possibility of further advection of colder air over that region.

(d) So long as there is a cold pool or cold trough at the 500 mb. level, one should always keep in mind the possibility of thunderstorms even if the charts for the sea-level and the lower levels in the upper air do not give clear indications of such a possibility. The case of 14-4-52 is a definite pointer in this direction. The streamlines on the constant level upper wind charts at 2,000' and 5,000' a.s.l. at 02 G.M.T. on 14-4-52 are shown in Figs. 1 and 2 and the

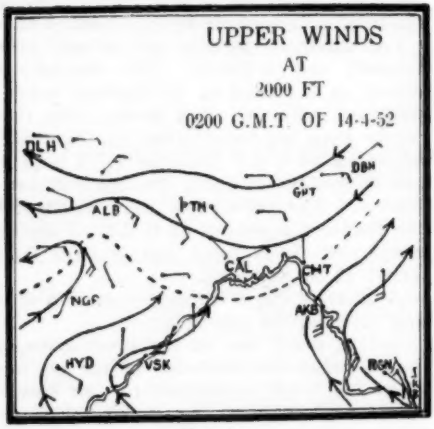

FIG. 1.

thermal winds and thickness patterns at the 500 mb. level on the evening of 13-4-52 are shown in Fig. 3. The thunderstorms which developed between the afternoon of 14-4-52 and morning of 15-4-52 are superposed on the thickness patterns in Fig. 3. It is of special interest to note here that the weather travelled most unusually from Gangetic West Bengal to Chotanagpur on this afternoon and that the nor'westers over Gangetic West Bengal were not associated with any earlier development in Eastern Pakistan or Lower Assam. The thunderstorms over Aijal and Chittagong shown in Fig. 3 were an independent development and occurred in the early hours of 15-4-52.

In addition to the above seven cases, the authors have also made a general study of situations which nor'westers did *not* develop over West Bengal although the sea-level and the upper air conditions *below* 10,000' were

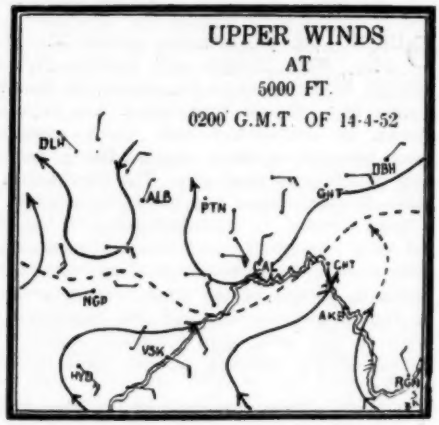

FIG. 2.

favourable according to the present accepted ideas. On such occasions, it has been found that there was no cold pool or even a weak cold

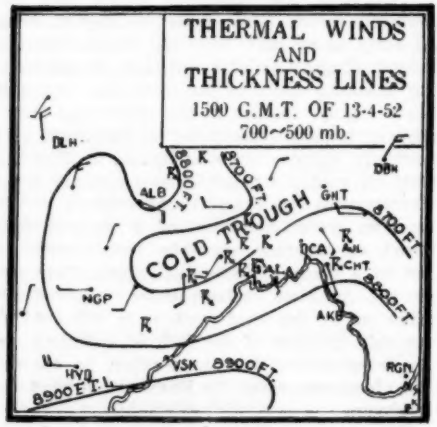

FIG. 3.

trough at the 500 mb. level in or near the region where nor'westers could be expected from other evidence. The situations on 2nd and 11th March and 2nd April‡ 1953, are instances in support of this staement.

The authors would have liked to study in detail the thickness patterns at the 300 mb. level

‡ Added at proof stage.

(500 — 300 mb.) also but the paucity of thermal wind data for this level discouraged them from undertaking the study at this stage. They would, however, like to mention that in the cases of nor'wester activity on 5-6-52 and 6-6-52 for which adequate amount of thermal wind and thickness data were available, there were very well-marked cold troughs at the 300 mb. level also, 18-24 hours before nor'westers developed. The thermal winds (500 — 300 mb.) in these cases were SSE/SW over the entire region where the nor'westers developed while the actual winds in the same region were SW/W.

From the above, the authors are tempted to conclude that the advection of colder air between 10,000′ and 20,000′ and possibly also between 20,000′ and 30,000′ appears to be the *final determining factor* in the outbreak of nor'westers, at least when they are widespread.

In conclusion, it may be pointed out that the technique adopted by the authors in this investigation is a simple one, not open to any theoretical objection from the point of view of validity of the geostrophic assumption, as the phenomena of nor'westers occur in regions to the north of latitude 20° N. and during a period of the year when the westerlies are predominant over north-east India and Eastern Pakistan in the upper air. Further, there is usually a fairly adequate amount of Pilot Balloon wind data at the 500 mb. level over India except on very cloudy days and the accuracy of these data is quite well known. Consequently, it is possible to identify the existence of cold pools or cold troughs qualitatively even from the thermal wind circulation patterns on days on which Radiosonde data are not available or are not reliable on account of instrumental errors.

Full details of the seven cases referred to above, together with diagrams showing the thermal winds and thickness patterns at the 500 mb. level and the thunderstorms superposed upon these patterns for purposes of comparison are being sent for publication in the *Indian Journal of Meteorology and Geophysics.*

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MENDELIAN ANOMALIES

R. H. RICHHARIA AND AYODHYA PRASAD
Agricultural Research Institute, Sabour, Bihar

THOUGH over fifty years have elapsed since Mendel's Law of Segregation was rediscovered by three different investigators, De Vries, Correns and von Tschermak in 1900, no attempt apparently seems to have been made to collect systematically Mendelian anomalies, occasionally observed in experimental data and scattered in the genetic literature. Not without exception every population has a classical Mendelian ratio of 3 : 1, etc. Thus in the course of intensive genetic research during the past fifty years, it has not been a rare observation that abnormal segregations in families, arising from various crosses, have been recorded by different authors, who have also expressed doubts in regard to offering an explanation on ordinary Mendelian lines. For example, Luther Smith[8] in his review on genetics and cytology of barley has rightly remarked, "Workers who have studied many genetic characters have noted that not all F_2 segregations are exactly 3 : 1, although only one gene pair is involved. There are a number of possible reasons for this discrepancy between theoretical and observed ratios. However, not many workers have taken the time and trouble to determine which of the possibilities actually obtain".

Yule[14] reporting on the data afforded by the experiment initiated by Derbyshire, remarked, "No explanation is offered of the remarkable divergences from the expectation based on simple Mendelian theory; they remain a puzzle. But it seems clear that the theory is inadequate completely to explain all the facts. The mechanism at work appears to be more complex than is commonly postulated". Also Bateson's[1] remarks in this connection that "even as regards the outline of genetical principles, finality has not been attained," may not be out of place to record.

Again, Pease[10] working on the inheritance of

weights in rabbits, recorded, "A plausible explanation of this on ordinary Mendelian lines does not seem possible".

There also exists enough evidence to show that a particular character is determined by one pair of factors in a particular set of experiments while in another set the same character was determined by two pairs of factors or even more. Such cases are not infrequently recorded in the genetic literature on rice,[7] where out of 189 pairs of characters analysed, 40 show such inconsistent inheritance. Cases have also been recorded by some workers where results agreed not with the expected ratio but with other values.[2]

It is also not very rare to find that out of a large number of F_2 families in a particular cross, grown from individual F_1 plants, one or more, showing significant deviations.

In the course of our work, we have made a critical survey of genetic literature from this point of view and classified the data on Mendelian anomalies into five different types as given below, to prepare a code of these deviations.

Classification of Mendelian Anomalies

(*a*) *Ordinary Deviations*

Generally, in an experiment on Mendelian segregation involving one pair of genes, the different populations belonging to the dominant character bear to the populations belonging to the corresponding recessive character, ratios both greater and less than three for different families of a generation. Similar conditions hold good in cases dealing with more pairs of genes. In such a case the statistically significant deviation is said to be of the ordinary type.

(*b*) *Unidirectional Deviations*

When for different families of a generation, the ratios of segregation are all either greater than or less than the expected values, the deviation is said to be unidirectional.

(*c*) *Evolutionary Deviations*, i.e., *Deviations Observed in the Generations*, F_n, F_{n+1} ....

When the ratio of segregation tends to either decrease or increase as we go upward in the generations F_n, F_{n+1} ,.... the deviations are said to be evolutionary. It is suggested that due to the action of an evolutionary factor, the trend of deviations in the series F_n, F_{n+1}, ... is directed towards a definite genetic equilibrium.

(*d*) *Aberrant Segregations*

Those segregations which cannot strictly be assigned to the Mendelian type, are said to be aberrant and they ought to be called Mendelian puzzles.

(*e*) *Inconsistent Inheritance*

It is not very rare to observe a particular pair of characters being controlled by, say, one pair of genes in some cases and the same pair of characters controlled by two or even more independent pairs in other cases. Such cases of inheritance are examples of inconsistent inheritance.

It is envisaged that the above code might help those interested in the subject to offer explanations or formulate corollaries to Mendel's Law of Segregation, such as the Hardy-Weinberg Law, connected with population genetics. (Sinnott, Dunn and Dobzhansky[12]).

In this connection, Bateson[1] once remarked that "though we can no longer doubt that segregation is, perhaps by more than one process, commonly effected at the reduction division, evidence steadily accumulates showing that at least in plants of many kinds comparable segregations occur in somatic divisions also". Naturally, this constitutes one of the factors responsible for the complexity of the phenomena of segregations. Unless the interrelations and inter-actions of somatic divisions on one hand and reduction divisions on the other, are thoroughly understood, the complexity will continue to be a puzzle. The recent cytological investigations carried out by Huskins and his co-workers,[4,5] Wilson and Cheng,[13] Huskins and Cheng[6] and Menzel and Brown[9] on chromosome multiplication and reduction in somatic tissues and somatic segregation, require further extension and application since these authors have not thrown any light on the bearing of these biological processes on Mendelian heredity. For this very reason Franzke and Ross[3] remarked, "If this phenomenon is more than an apparent separation, it is surprising .....that some mention of effects on heredity resulting from such chromosomal separations has not been made". These authors found, "Colchicine treatment of full sibs of a true breeding variety of sorghum gave variants possessing a number of ancestral characteristics of which some bred true immediately. Untreated stock of a full sib of the above has not segregated in subsequent generations. In no case among these has the chromosome number been found changed". Considering the question of segregation observed in F_2 progenies from treated F_1 and untreated F_1 plants, it is very significant to observe that the results of segregation in F_2 progenies in the case of height of plants, were different in these two cases. "The distribution from progeny of treated F_1

plants shows a definite concentration around one point causing a distinct difference in form of this distribution from that of the untreated which approaches that of a normal curve. This and the lower mode of the progeny from treated F_1 plants demonstrates a significant difference in degree of uniformity found within progenies from treated plants as against progenies from untreated plants". Thus colchicine treatment causes homozygosity in respect of height of plants thereby modifying the normal segregation. So far as we know, none has carried such investigations, a step ahead to examine the nature of the resulting anomalous segregations in generations like F_2, F_3, etc. A contribution to Mendelian anomalies coming from this direction, is yet to be settled.

Richharia[11] had also made similar observations on colchicine-induced variants in respect of oil percentages in *Sesamum orientale*. He found that colchicine treatment of plants of a true breeding variety of sesame gave variation in respect of oil percentages between 51·21 and 54·13, whreas the normal progenies varied between 51·19 and 53·80 per cent.

1. Bateson, W., *J. Genet.*, 1926, **16**, 201–35. 2. Brieger, F. G., *Ibid.*, 1935, **30**, No. 1, 79. 3. Franzke, C. J. and Ross, J. G., *J. Hered.*, 1952, **43**, 107-15. 4. Haskins, C. L., *Nature*, 1948, **161** 80-3. 5. —, *J. Hered.*, 1948, **39**, 311-25. 6. Huskins, C. L. and Cheng, K C., *Ibid*, 1950, **41**, 13-18. 7. Kadam, B. S. and Ramiah, K., *Indian J. Genet. and Pl. Breed*, 1943, **3**, No. 1, 7-27. 8. Luther Smith, *Bot. Rev.*, 1951, **17**, No. 3, 133-202. 9. Menzel, M. Y. and Brown, M. S., *Amer. Jour. Bot.*, 1952, **39**, 59–68. 10. Pease, M. S., *J. Genet.*, 1928, **20**, No. 2, 261. 11. Richharia, R. H., *Progress Report of the Oilseed Research Scheme, C P and Berar* (1940-41). Govt. Printing, C. P. and Berar, Nagpur, 1941, 22-3. 12. Sinnott, E. W., Dunn, L C, and Dobzhansky, Th., *Principles of Genetics*, McGraw-Hill Book Company, Inc., London, 1950, 307. 13. Wilson, G. B, and Cheng, K. C., *J. Hered.*, 1949, **40**, 3-6. 14. Yule, G. Udny, *J. Genet.*, 1923, **13**, No. 3, 255.

STREPTOMYCIN AND ISONIAZID

THE Second Report* to the British Medical Research Council by the Tuberculosis Chemotherapy Trials Committee gives the results of three months' treatment of 364 patients suffering from pulmonary tuberculosis of different degrees of severity. Of these, 142 were treated with streptomycin 1 g. daily and isoniazid 100 mg. twice a day, 102 with streptomycin 1 g. daily and sodium *para*-aminosalicylate (P.A.S.) 20 g. daily, and 120 with isoniazid 100 mg. twice a day alone. Over this period streptomycin and isoniazid, given together, were superior to streptomycin and P.A.S. in their effect on weight gain and blood sedimentation rate, and rather more effective in improving general condition. There was no significant difference in the effect on pyrexia, sputum-conversion or the radiographic appearances. Comparison of streptomycin and isoniazid with isoniazid alone, over the same period, showed that the combined treatment was much more effective in lowering the sedimentation rate and improving the radiograph. It was slightly more effective in returning the temperature to normal. The effect on general condition and on weight was similar with both treatments.

When streptomycin and isoniazid are given together, the reciprocal suppression of drug resistance is of the same order as that of streptomycin and P.A.S. over a three-month period. But the few available figures for isoniazid resistance at four months are less reassuring. Three out of eight positive cultures were resistant, though in most of these patients streptomycin was given only three times a week in the fourth month. Until more evidence is available, these results suggest caution in giving streptomycin less often than once daily when it is used with isoniazid, and we do not know that the combination will maintain its clinical superiority when continued for more than three months.

The chemotherapy of tuberculosis is no longer simple. Its very success and diversity are creating ever-changing problems with which everyone who treats the disease must become familiar. The pace of research is such that even the conclusions of the present authoritative report may be out of date in a few months.

* *B. M. J.*, March 7, 1953, p. 521.

DR. GILBERT J. FOWLER—OBITUARY

DR. GILBERT JOHN FOWLER, who died on March 21, 1953, at Bangalore, was a great authority on the subjects of treatment of sewage and trade effluents and of nitrogen conservation. He will be principally remembered as the pioneer of the Activated Sludge Process, which is perhaps the most efficient and hygienic method of sewage treatment so far developed.

Gilbert John Fowler was born in Paris on January 23, 1868. He was educated at Owen's College, Victoria University, Manchester, where he became a Demonstrator in Chemistry after taking his B.Sc. Degree. Later he was appointed a Lecturer in the University of Manchester and Consulting Chemist to the Rivers Committee of Manchester Corporation. During this period (1896-1916) he was responsible for the treatment of sewage and trade effluents of Manchester. He was awarded the D.Sc. Degree of the University of Heidelberg in 1904. He won international reputation when he and his associates, particularly the late Dr. E. Ardern and Mr. W. T. Lockett, developed at Manchester the Activated Sludge Process in 1914.

On problems of sewage disposal Dr. Fowler was consulted by the cities of New York, Cairo, Shanghai and Hankow, and by the Government of Federated Malay States. He was also a consultant to the Government of India and to various State Governments. He had been periodically visiting India in an advisory capacity from 1906 and in February 1916 he took his permanent residence in India when he became the Professor of Applied Chemistry and later (1921) of Biochemistry in the Indian Institute of Science, Bangalore. Even after his retirement from the Institute in 1924, he was taking very keen interest in the activities of the Department. Excepting for brief periods, *e.g.*, when he was the Principal of the Harcourt Butler Technological Institute at Kanpur (1927-29), he was throughout in Bangalore.

One of the most important lines of work in the Department of Biochemistry since Dr. Fowler's association with the Department has been naturally concerned with the scientific control of sewage and refuse disposal in all its aspects including its relation to agriculture. In 1922 an activated sludge plant was designed and set up at the Institute capable of dealing with the sewage from a campus of 400 people. This installation has enabled important fundamental research to be done on the biochemistry of the process which has thrown considerable light on the mechanism of aerobic purification of sewage. After a visit to Rothamsted in 1921 when he became acquainted with the so-called ADCO process, Dr. Fowler took a great interest in the production of compost. Since then the subject has become one of the leading manurial activities of India and many students of the Biochemistry Department have taken an important part in the work throughout the country. He was continually interested in activated sludge, in compost and in other aspects of recovery of nitrogen from waste materials for soil fertilisation and crop production. In articles, in lectures and addresses he was not tired of developing and enlarging his most favourite theme of nitrogen conservation.

Dr. Fowler has written three books, *viz.*, *Sewage Works Analyses* (1902), *An Introduction to Bacteriological and Enzyme Chemistry* (1911) and *An Introduction to the Biochemistry of Nitrogen Conservation* (1934), a pamphlet entitled *Energy and Economics—A Plea for a New View Point* (1941), and a large number of papers and articles in various journals. He was the Technical Representative of Messrs. Activated Sludge, Ltd., London, for India and the East from 1925. He was a Fellow of the Royal Institute of Chemistry (and the Hon. Corresponding Secretary for India till 1951); Fellow of Chemical Society of England; Fellow of the Royal Sanitary Institute; Hon. Member of Manchester Literary and Philosophical Society; and Member of Industrial Research Council of the Government of India, 1937-39. He was President of Chemical Section of Indian Science Congress in 1918; of Indian Chemical Society in 1927; and of the Society of Biological Chemists, India, 1947-49.

Dr. Fowler was held in high esteem and regard by those who came into contact with him. He is survived by his wife and two sons.

K. V. GIRI.
R. RAJAGOPALAN.
S. C. PILLAI.

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A GENERAL THEORY OF DISCRIMINATION WHEN THE ALTERNATIVE POPULATION DISTRIBUTIONS INVOLVE UNKNOWN PARAMETERS

The problem of discrimination, that is of assigning an observed individual to its proper group, admits a simple solution when the distributions of measurements in the alternative populations are completely specified. In practice, the alternative distributions are not completely known but may be estimated on the basis of samples drawn from each alternative population. It can be formally demonstrated that if the parameters are based on large samples, then the above solution in which the estimates are substituted for parameters is asymptotically the most efficient. The small sample case needs some investigation. The problem may be stated as follows:

Two samples of sizes n_1 and n_2 are available from two populations P_1 (x/θ_1) and P_2 (x/θ_2), where x stands for all the measurements and θ for all the parameters. An individual with known measurements y has to be assigned as a member of one of the two groups basing the decision on the observed values only, the parameters occurring in the alternative distributions being unknown. Wald[1] proposed to solve this problem in the case of p-variate normal populations by finding the distribution of the estimated discriminant function earlier suggested by Fisher for classificatory purpose. This involves unknown parameters and cannot, therefore, be applied in practice. In this note an attempt is being made to lay down a decision rule independent of the unknown parameters.

If the measurements are p in number, we have a total of $(n_1+n_2+1)p$ observations which can be represented by a point in a Euclidean space. The decision rule requires the division of the space into two regions R_1 and R_2 such that when the point of observations falls in R_1 the individual is assigned to the first group and otherwise to the second. Whatever may be the set of regions, it should have the property that errors of classification when the alternative populations are different must be smaller than those when the populations are the same. This criterion leads to the restriction that the size of each region should be the *same* whenever the two probability densities P_1 and P_2 are identical irrespective of what

the actual values of the common parameters are. This part of the problem is immediately solved if similar regions exist with respect to all the unknown parameters when the probability densities are the same.

We have now to fix the size of the regions $a_1(\theta, \theta)$ and $a_2(\theta, \theta)$ of R_1 and R_2 when P_1 and P_2 are identical. When the population distributions are identical, the decision may be equivalent to that of tossing an unbiased coin so that it is reasonable to take $a_1 = a_2 = \frac{1}{2}$. We could also fix them by assigning the ratio of errors of classification at a specified set of parameters in the two different distributions. The special case of fixing $a_2(\theta, \theta)$ at the 5% level leads to a test of the null hypothesis that the individual belongs to the first group at level $\leqslant 5\%$, the alternative being the second group. Similarly, the other null hypothesis can be tested.

The problem is now to determine such similar divisions R_1, R_2 covering the entire space which have fixed values when the two distributions are identical and for which the errors of classification is a minimum. In many cases, similar regions are constructed by choosing portions from surfaces of constant values of sufficient statistics. The problem of minimising the errors reduces to suitably dividing the region common to the surfaces of sufficient statistics as in the general problem of testing composite hypothesis.

Again, in all cases, no uniformly best division is possible on the surfaces of sufficient statistics. We may then determine regions for which the errors of classification is least, at least locally, i.e., for small departures from the equality of populations.

By using these principles, it has been possible to solve the discrimination problem as well as testing of hypothesis in a number of cases including multivariate normal distributions by just utilizing the observed values only and making no assumption about the unknown parameters.

The theory is general and can be applied even when the alternative distributions are more than two. The detailed mathematical treatment will be published elsewhere. Related problems of selection, greater mean, etc., can also be easily solved by this method.

Statistical Laboratory, C. RADHAKRISHNA RAO.
Presidency College, Calcutta-12,
February 24, 1953.

1. Wald, A., *Ann. Math. Stat.*, 1944, **15**, 145.

OCCURRENCE OF GYPSUM IN PALLADAM TALUK, COIMBATORE DISTRICT

THE whole area near Anuppapatti village, Palladam taluk, is a vast stretch of black cotton soil extending to thousands of acres and the topography is very undulating with heavy formations of gullies due to soil erosion. Gypsum occurs as modules of varying sizes both in the profile and as an outcrop as well in a basin covering about 200 acres. The profile deposits are present at a depth of 2'-8' depending on the topography. Blocks of granites, gneisses and *kankar* of different sizes are found on the surface.

The clay content of the soil ranges between 48 to 55 per cent., the lower depths being heavier than the surface and subsoil. The soils are alkaline in reaction (pH 8·2 to 8·6) and contain high amounts of water-soluble salts, mostly the sulphates of sodium, calcium and magnesium; the carbonates and bicarbonates of sodium being completely absent. The water-soluble salt content also shows an increase with depth, the lower depths having higher concentrations than the surface and subsoil. A petrological analysis of the samples reveal the presence, in addition to gypsum, of the following minerals, *viz.*, quartz, ferro-magnesium minerals, etc. Gypsum is found associated with *kaolin* and *kankar*, the latter being present throughout profile either in a nodular form or as streaks.

The soils of this area are similar to the black cotton soils with gypsum occurring in the Rayalaseema (Ceded Districts) in all respects, *viz.*, parent material, mode of formation, salt concentration, texture and other physical characteristics.

In view of the absence in the soil of salts toxic to plants or inhibitory to their growth in the top zones, the high lime status and the dry intensive cultivation that is being followed, the area would continue to support good vegetation provided suitable precautions are taken against soil erosion and consequent depletion of soil fertility.

The formation of a zone of gypsum concentration is only secondary which may be due to the absence of heavy leaching and to the high retentive and absorptive capacity of the clay complex present in the soil. The gypsum nodules contain the hydrated sulphate of lime in a crystalline form, crystallised in the monoclinic system in flat rhomboid tables and the crude material as obtained fresh from the field contains 65% $CaSO_4$. A rough estimate puts

the probable quantity that could be obtained from one acre at about 400 tons of the crude material. A detailed paper incorporating complete analytical data will be published shortly.

Chemistry Section, M. SANYASI RAJU.
Agric. Res. Institute, C. R. VENKATRAMAN.
Lawley Road P.O., Coimbatore,
February 12, 1953.

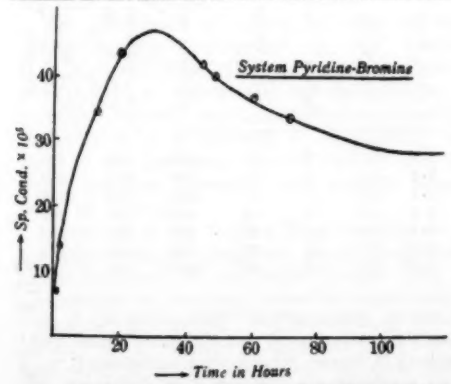
A NOTE ON THE REACTION BETWEEN PYRIDINE AND BROMINE IN THE LIQUID STATE

IN continuation of the author's previous work on the pyridine-iodine[1] system, the reaction between pyridine and bromine has been investigated at 20° C. by studying the time-variation of specific conductivity of bromine solution in pyrdine. The colour of the solution just after adding bromine is golden yellow, but changes to deep reddish brown when kept for 2-3 days. The accompanying table gives the changes in sp. cond. with time.

TABLE

(*Temperature* 20° *C.*; *Conc. of Bromine* 2·92 *gm./l. or* 0·0180 M. *Specific Conductivity of Pyridine is about* 9×10^{-8} *mhos*)

Time	Sp. cond. in mhos
20 mins.	$6{\cdot}705 \times 10^{-5}$
2 hrs.	$1{\cdot}350 \times 10^{-4}$
13 ,,	3·490 ,,
19 ,,	4·336 ,,
44 ,,	4·180 ,,
48 ,,	4·011 ,,
60 ,,	3·665 ,,
71 ,,	3·398 ,,
599 ,,	2·885 ,,



From the table it appears that the conductivity first rises but then falls off slowly. This behaviour is somewhat different from that of iodine in pyridine where conductivity goes on rising, probably attaining the maximum value at infinite time. The nature of variation is clearly brought out by the accompanying figure.

The colour change from golden yellow to the deep brown is very rapid and marked, and is unlike the slow colour change of the pyridine-iodine system. The rise in electrical conductivity with time may be tentatively accounted for, as for the pyridine-iodine system, due to the formation of ionic species of the type

$$C_5H_5{\cdot}N + 2Br_2 = C_5H_5N{\cdot}Br^+ + Br_3^-$$
$$C_5H_5{\cdot}N + Br_2 = C_5H_5N{\cdot}Br^+ + Br^-$$

It is, however, not clear what reaction is responsible for the slow disappearance of these ionic species in the present case.

Detailed investigation is in progress to elucidate these points and the results will be published in detail elsewhere.

Chemistry Dept., RAM GOPAL.
Lucknow University,
February 20, 1953.

1. *J. Ind. Chem. Soc.*, 1952, p. 898.

EFFECT OF BORIC ACID ON THE ACTIVITY OF INVERTASE

IT is well known that boric acid forms a complex with sucrose which is taken advantage of in its quantitative estimation.[1] It was, therefore, thought of interest to examine how the catalytic activity of invertase is affected by the presence of boric acid in the reacting system.

The invertase sample used for the investigation was the same as described previously.[2] The stock invertase preparation had a time value of 58 minutes per c.c. In the present work we have taken arbitrarily the activity of invertase present in 1 c.c. of this preparation as 100 units, and measured the activity of other solutions in terms of this standard.

The number of milligrams of invert sugar produced by different quantities of stock invertase preparation was determined by following a special procedure.[3] A graph is then constructed by plotting the number of milligrams of invert sugar produced against the number of arbitrary units of invertase used. The activity of any other preparation can then be found out by determining the number of milligrams of invert sugar produced under specified experimental conditions and referring to the graph.

To study the effect of boric acid, 2·5 c.c. of the concentrated invertase (1 c.c. = 100 units)

is diluted to 100 c.c. by buffer solution of required pH using as much quantity of saturated solution of boric acid as is required to give a particular concentration of boric acid in the final solution. The mixture is kept at 25° C. for 5 minutes and the activity is determined as described earlier.[3] The results obtained with different quantities of boric acid at different pH values show that the activity of invertase is brought down by about 20 to 25 per cent. by the presence of 6·7 per cent. boric acid in the reacting mixture. Further work is needed to decide as to how far this effect is due to the complex formation between sugar and boric acid and that between invertase and boric acid.

Ind. Inst. of Sugar Tech., Kanpur, *December* 17, 1952.

K. S. G. Doss.
H. C. Saraswat.

1. Clowes, F. and Colman, J. B., *Quantitative Chemical Analysis*, 13th Ed., J. & A. Churchill Ltd., London, 1931, 150. 2. Doss, K. S. G. and Saraswat, H. C., *Proc. Ind. Acad. Sci.*, 1952, **36**, 343. 3. —, *Ibid.*, 1953, **37**, 63.

ESTIMATION OF *p*-CYMENE BY OXIDATION TO TEREPHTHALIC ACID

The semi-quantitative method of estimating *p*-cymene by its oxidation to terephthalic acid, developed by Linstead and co-workers,[1] was tried in our investigations. Pure *p*-cymene (b.p. 176-76·5° C., n_D^{26} 1·4890), obtained by purifying an Eastman Kodak sample, was oxidised, and the results are summarised in Table I-A, the yield of terephthalic acid being 425 mg. as compared to 370 mg. reported by Linstead *et al.*, and not much altered by increasing the weight of CrO_3 to 4 g.

Trial experiments revealed that the discrepancy between our and Linstead's results might be due to the mode of carrying out the oxidation process. If, at the start, the oxidation is made to take place vigorously, the yield of terephthalic acid is greater than the yield obtained with a mild and slow heating from the beginning, as is seen by comparing the results of Tables A and B. The yield of acid from slow oxidation is similar to that obtained by the other authors.

For the sake of comparison, the unpurified Eastman Kodak *p*-cymene was subjected to the rapid and to the slow oxidation under otherwise identical conditions, and the results obtained are included in C and D of Table I. It is to be noted that the rapid oxidation brings out quite clearly the difference between the purified and unpurified samples of *p*-cymene (A and C of Table I), whereas the slow oxidation procedure gives approximately the same amount of terephthalic acid for the two samples of *p*-cymene (B and D of Table I) and therefore appears to be non-specific.

Also an attempt was made to evaluate the effect of changing the relative proportions of sulphuric and acetic acids on the yield of terephthalic acid from purified *p*-cymene under rapid oxidation conditions, and the results are presented in E of Table I. The yield is now pushed up to about 474 mg. The result obtained with this more favourable acid mixture and rapid oxidation from unpurified *p*-cymene sample is given in F of Table I. The *p*-cymene content of this latter sample, on the basis of the purified sample as cent. per cent. works out to be 93 per cent. A similar calculation applied to the yields from the two samples of *p*-cymene with the lower acid content mixtures and rapid oxidation (A and C of Table I) leads to a value of 93 per cent. The identity of these two values seems to confirm the validity and reproducibility of the rapid oxidation procedure and of estimation of *p*-cymene content of a given sample by this method.

On replacing CrO_3 by the more readily available and less hygroscopic potassium dichromate, rapid oxidation of purified sample of *p*-cymene, gave an average yield of 475 mg. of terephthalic acid (*cf.* G of Table I), fairly close to the yield of 472 mg. obtained with CrO_3 (*cf.* E of Table I).

Table I

Oxidation of p-*cymene to terephthalic acid* (*time*, 3 *hrs.*)

	CrO_3 in g.	Water c.c.	H_2SO_4 c.c.	CH_3COOH c.c.	*p*-cymene mg.	Terephthalic acid (T) mg.	T in mg. per 450 mg. of *p*-cymene
A	3·5	15	5	15	406	383	425
B	3·5	15	5	15	399	319	359
C	3·5	15	5	15	403	356	396
D	3·5	15	5	15	409	332	365
E	3·5	15	10	20	413	435	474
F	3·5	15	10	20	439	429	439
G	3·0*	15	10	20	416	440	476

A and E, pure *p*-cymene, rapid oxidation; B, pure cymene slow oxidation; C and F, impure cymene, rapid oxidation; D, impure cymene, slow oxidation; G, pure cymene, rapid oxidation with potassium dichromate.

* CrO_3 equivalent of $K_2Cr_2O_7$.

For the present, it may be concluded that 450 mg. of pure p-cymene should, on rapid oxidation with CrO_3, give 425 mg. of terephthalic acid with the acid mixture indicated in A of Table I, and about 475 mg. with the higher acid mixture of E of Table I. This latter yield can also be obtained with potassium dichromate as indicated by G of the same table. The reason for the reduced yields of terephthalic acid on slow oxidation and the nature of the experimental conditions for securing yields approaching the theoretical value are under investigation.

M. Leo Xavier.
James Verghese.
Lourdu M. Yeddanapalli.

Dept. of Chemistry,
Loyola College, Madras-6,
January 30, 1953.

1. Linstead, R. P., Michaelis, K. O. A. and Thomas, S. L. S., *J. Chem. Soc.*, 1940, 1139.

EVIDENCE FOR COMPLEX FORMATION OF IODINE WITH SOLVENTS

The general opinion seems to be that iodine forms a complex with solvents having an electron-donor group. Such a co-ordinated link might polarise the iodine molecule and make it more reactive.[1]

Mixed solvents were used by us to study the effect of the progressive increase of such complex molecules. The effect of iodine complex is very pronounced with systems of water-ethanol mixtures in the reaction between sodium formate and iodine and the photo-chemical reaction between potassium oxalate and iodine. The rate of reaction is faster with greater proportions of alcohol.

The hydrolysis of iodine in water solutions (without KI) according to the equation $I_2 + H_2O \rightleftharpoons HIO + HI$ in presence of platinum as catalyst is accelerated by the addition of alcohol. Specific conductivity measurements at intervals show an increase in conductivity with time in all the cases, but the rate of this zero order reaction increases with greater proportions of alcohol.

Loosening of the binding force between I-I by the formation of complexes must considerably strain the bond I-I and make it more easy for atomisation or to bring into chemical reaction with other substances. Our preliminary experiments show that there is increased light absorption with increased reactivity in such iodine complexes, also in mixed solvents like water-alcohols, water-dioxane and water-acetone mixtures, thus adding proof to the earlier work of Dhar and Bhattacharya.[2]

Chemistry Dept., A. K. Bhattacharya.
University of Saugar, N. R. Subbaratnam.
December 20, 1952.

1. Feigl and Bondi, *Monatsch*, 1928, **49**, 417. 2. Dhar and Bhattacharya, *J. Ind. Chem. Soc.*, 1934, **11**, 311.

EFFECT OF LIPID EXTRACTION ON DIPHTHERIA ANTITOXIC PSEUDOGLOBULIN

It is well known that liquid antitoxic sera lose 5 to 10 per cent. of their potency every year even when stored in cold. This deterioration can be avoided by lyophilisation of the liquid sera. However, the lipoproteins present in liquid sera get denatured and become insoluble during lyophilisation.[1] Lahiri[2] has been able to increase the solubility of the lyophilised product by previously extracting the liquid sera with ether at 0° C. in presence of 0·1 per cent. sodium taurocholate. Other workers[3-5] have used mixtures of alcohol and ether at temperatures below −10° C. Mixtures of alcohol and ether are very efficient solvents for lipoids but the extraction has to be carried out at low temperatures in order to avoid denaturation and loss of antibodies.

We have been working on a method of lipid extraction which can be used at room temperatures without loss of antibodies. The process worked out was such that it fits in easily into the Gibson-Murdick[9,10] method of concentration of antitoxic sera used in our laboratories for large-scale work. The method finally adopted for lipid extraction is briefly as follows.

The pressed cake of anti-diphtheria horse serum pseudoglobulin fraction precipitated by ammonium sulphate between 30 and 50 per cent. saturation was dried in a desiccator to less than 1 per cent. moisture content. To every 50 g. of the dry powdered material in a 250 ml. centrifuge tube, 100 ml. of a mixture of equal volumes of freshly distilled ether and absolute alcohol were added, shaken for 10 minutes and centrifuged. The clear solvent layer was decanted. The residue was mixed with 50 ml. more of the solvent and extracted as before. In all, three extractions were carried out. The precipitate was finally washed with 50 ml. of ether and de-etherised by exposing it to air in thin layers and finally dialysed. It was found after dialysis that there was a large amount of precipitate which could be removed by adjust-

ing the pH to 5·5. The clear supernate contained all the antibodies.

Seven lots of anti-diphtheria horse plasma were processed in this manner. In no case was there a loss of antibody, but, on the other hand, there was an increase in antibody titre ranging from 11 to 42 per cent. per g. of protein nitrogen as compared with the controls.

Electrophoretic analysis of the lipid extracted and unextracted sera were carried out in the Hilger electrophoresis apparatus at pH 7·6 in phosphate buffer of 0·1 ionic strength. Figs. 1

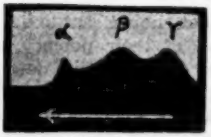


FIG. 1

FIG. 2

FIG. 1. Concentrated anti-diphtheria horse pseudo-globulin.

FIG. 2. Lipid extracted concentrated anti diphtheria horse pseudo-globulin.

and 2 are the ascending patterns for unextracted and extracted samples respectively. It is seen from the photographs that the peak for alpha-globulin is missing in the extracted sample. The increase in antibody titre of the lipid extracted sample is thus due to the removal almost completely of the alpha-globulins which have no antibodies associated with them. The conversion of soluble alpha-globulins into water-insoluble proteins after lipid extraction does not seem to have been noted by others. Details will be published elsewhere.

The authors wish to thank Dr. D. C. Lahiri and Dr. P. M. Wagle for their keen interest and help.

Dept. of Antitoxins & Sera, Haffkine Institute, Bombay-12,
V. Y. MORE.
S. S. RAO.

February 18, 1953.

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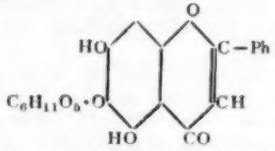
TETUIN, A GLUCOSIDE FROM THE SEEDS OF *OROXYLUM INDICUM* VENT.

DETAILED examination of the seeds of *O. indicum* Vent. yielded the following substances: (1) A non-drying fatty oil;[1] (2) a yellow crystalline substance (m.p. 274° C.);[1] (3) Baicalein;[2] and (4) a pale yellow crystalline substance (m.p. 112-14° C., sintering at 77-78° C.) named Tetuin.

Tetuin, $C_{21}H_{20}O_{10}$, has been isolated from the alcoholic and water extracts of the defatted powdered seeds. Tetuin on hydrolysing with dilute mineral acids gave Baicalein, $C_{15}H_{10}O_5$ (m.p. 265-66° C.), and glucose, both of which have definitely been identified by the study of the properties and reactions of these substances and their derivatives.

The fact that Tetuin does not give green colour with alcoholic ferric chloride shows the absence of two hydroxyl groups in the ortho-position to each other. This is supported by the fact that it does not give ammonium molybdate acetic acid test for ortho hydroxyl groups.[3] Oroxylin-A, a yellow colouring matter obtained from the root bark of *O. indicum* Vent. does not answer this test.[4] Our results, therefore, indicate that Tetuin is Baicalein-6-glucoside and has the following structural formula.



Details of this investigation will shortly be published elsewhere.

L. M. College of Pharmacy, Ahmedabad,
C. R. MEHTA.
T. P. MEHTA.

January 5, 1953.

1. Mehta, C. R., *Proc. Ind. Acad. Sci.* (A), 1938, **9**, 390. 2. —, and Mehta, T. P., *Curr. Sci.*, 1943, **12**, 274. 3. Quastel, *Analyst*, 1931, **56**, 311. 4. Shah, Mehta and Wheeler, *J.C.S.*, 1936, 591.

SEPARATION AND ESTIMATION OF OVER-LAPPING AMINO ACIDS BY CIRCULAR PAPER CHROMATOGRAPHY USING DIFFERENT SOLVENT MIXTURES

ALTHOUGH the technique described before[1] gave generally adequate separation of most of the amino acids occurring in the protein hydrolysates, several groups of amino acids were unresolved by it, *e.g.*, the separation of glycine-serine-aspartic acid from each other, or of glutamic acid from threonine was difficult with

butanol-acetic acid-water as solvent mixture. Each group of these amino acids appears as one band on the chromatogram. In order to facilitate resolution of mixtures of such overlapping amino acids, recourse was had to the application of the following technique:

The overlapping amino acids which separate together as one single band with *n*-butanol-acetic acid-water solvent, was cut out and a separate chromatogram was run for each group of amino acids using pyridine-water solvent, the cut out paper strips being used as wicks for second development. It was also found that satisfactory two-dimensional chromatograms were obtained by using *n*-butanol-acetic acid-water mixture as first solvent, followed by pyridine water as the second solvent. The details are given below:

The position of the band of a particular amino acid group separated on the chromatogram run with *n*-butanol-acetic acid-water mixture was located by cutting out two small sectors on either side of a sufficiently big sector and spraying these with ninhydrin. These sprayed sectors were then replaced in their original positions and the area of the particular group of amino acid was traced with a pencil, keeping the ninhydrin stained ones as guide sectors. The area of the band was cut out, rolled in the form of a wick, one end of which was cut in the form of a brush and inserted into a hole made at the centre of another circular filter-paper. As usual the chromatogram was run using pyridine-water (80 : 20 v/v) as solvent mixture. In this solvent all the groups of overlapping amino acids separated into distinct individual circular bands (Figs. 1 and 2).

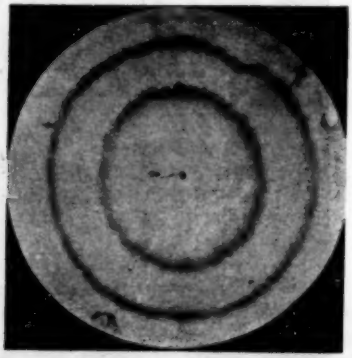


FIG. 1. Chromatogram showing the separation of glutamic acid and threonine which overlap and occur as single band in butanol acetic acid solvent.

For quantitative estimation, the bands relating to the overlapping amino acids were cut out. The amino acids were eluted by chromatographic elution and spotted on the circumference of a circle drawn at the centre of another

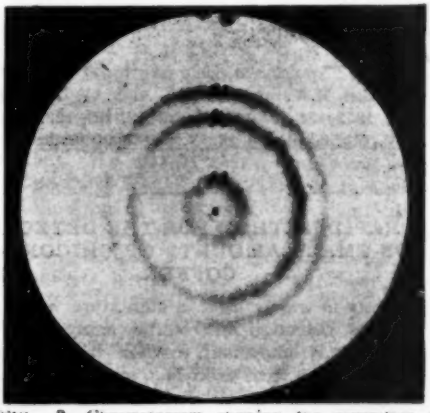


FIG. 2. Chromatogram showing the separation of aspartic acid, glycine and serine from each other, which overlap and occur as single band in butanol-acetic acid solvent.

filter-paper. Standard mixture of varying concentration of amino acids were also spotted on either side of the test spot and the chromatogram was developed with pyridine-water solvent. The bands separated on the paper after spraying with ninhydrin were cut out and the ninhydrin colour after elution with alcohol was estimated quantitatively according to the procedure described by Giri *et al.*[2] The results of a typical experiment carried out on the separation and quantitative estimation of a mixture of the overlapping amino acids containing 10 μg. of each amino acid, are presented in the following table.

Amino acids	Microgram of amino acids estimated after separation on the chromatogram
Aspartic acid ..	9·6
Glutamic acid ..	9·7
Glycine ..	10·0
Serine ..	9·4
Threonine ..	9·5

The results indicate that the method is reasonably accurate for quantitative estimations.

Further work on the quantitative analysis of all the amino acids present in protein hydroly-

sates by the application of this technique is in progress. Full details of this investigation will be published in the *Journal of the Indian Institute of Science.*

Dept. of Biochemistry, K. V. GIRI.
Indian Institute of Science, N. A. N. RAO.
Bangalore-3,
February 18, 1953.

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A RAPID METHOD FOR THE DETECTION OF SMALL AMOUNTS OF CHICORY IN COFFEE

CHICORY is widely used in admixture with coffee and its detection in routine analysis of this beverage is important. When the amount of chicory in coffee exceeds about 15 per cent., determination of "water-soluble extracts" along with microscopical tests usually helps in its detection. When, however, the percentage is less than 15, these tests are often inconclusive. A chemical test was, therefore, developed which would detect small amounts of chicory with certainty. Chicory contains inulin hydrolysis of which gives levulose,[1] while pure coffee contains dextrose only. The test which has been developed is based on this fact.

The detection of chicory can be conveniently combined with the determination of the "water-soluble extracts". 50 ml. of the highly coloured extract from the "water-soluble extracts" determination (2·0 per cent. coffee extract) are treated in cold with 3 ml. of 10 per cent. aqueous solution of lead acetate, shaken thoroughly and filtered after a while. At this stage the filtrate has a slight yellow tinge. To 5 ml. of the clear filtrate in a test-tube are added 5 ml. of freshly prepared Seliwanoff reagent (0·05 g. resorcinol dissolved in 100 ml. of 50 per cent. HCl) followed by 1 ml. of conc. HCl. The mixture is gently boiled for a minute and then allowed to stand for 10 minutes. The characteristic red colour due to levulose develops if chicory is present in even as low an amount as 1 to 2 per cent. Pure coffee under these conditions does not develop any appreciable red colour, but only a yellow tinge. With 2·5 per cent. chicory, the red colour matches with 7-8 red units of the Lovibond Tintometer whereas pure coffee gives a tintometer reading of 0·5-1·0 red unit. Further work is proceeding to give this test, if possible, quantitative character.

West Bengal Public Health Lab., Calcutta, S. N. MITRA. S. C. ROY.
November 22, 1952.

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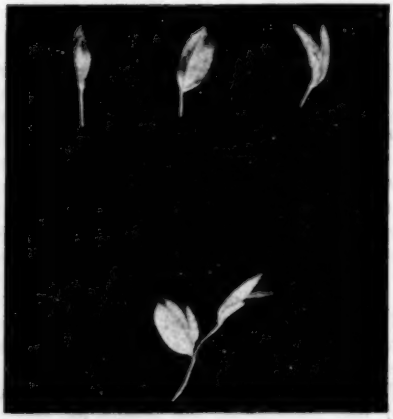
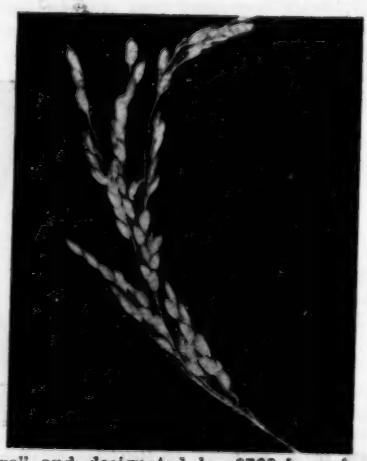
SOME ANOMALIES OCCURRING IN RICE, *ORYZA SATIVA* L.

IN a strain of rice plants, started from seeds obtained from Madagascar in 1948 through the courtesy of the "Inspection Générale de l'Agri-





culture" and designated by 0766 A, and which is undergoing genealogical selection ever

since 1949, one plant was found with panicles bearing some abnormal spikelets.

In some instances, but not very often, the spikelets appear ill-formed as a result of bearing the palea which is not fully developed; the caryopsis, on the other hand, in the absence of the protective wall offered by the palea, is either lacking or may develop quite abnormally, thus becoming longer and plump, conical in shape, more or less twisted and curved.

Sometimes, but less frequently, the atrophy of both inner glumes may take place, and they become reduced to two tiny scales. In such cases, the caryopsis always fails to develop.

Apart from the above-mentioned anomalies, empty glumes may occasionally be found which are larger in size than the normal ones.

Regarding other characteristics the plants may be considered as normal.

Some of the described aspects are shown in the above pictures.

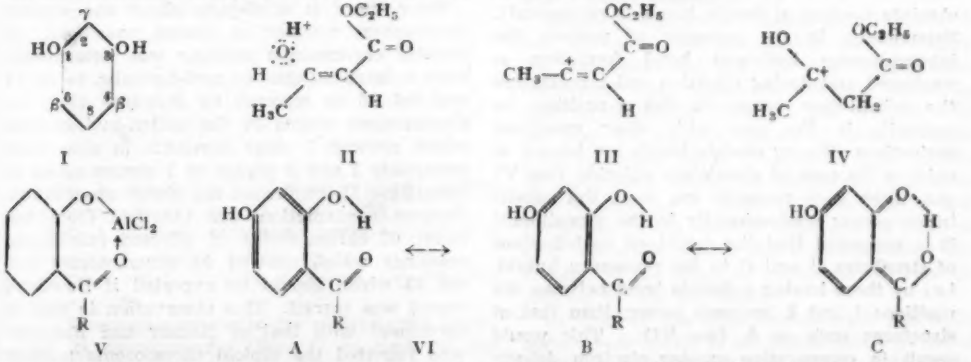
MANUEL VIANNA E SILVA.

Estaçao Agronòmica
Nacional Sacavém-Portugal,
December 5, 1952.

γ-SUBSTITUTION IN THE RESORCINOL NUCLEUS

IN a recent communication, Bafna and Shah[1] have discussed the mechanism of condensation of ethyl acetoacetate with particular reference to resorcinol derivatives having electron-attracting groups such as nitro or carboxyl in the β-position. The explanation put forward is based on two assumptions. Firstly, as the electron-attracting groups in the γ-position have less deactivating effect than when they are in the β-position, they suggest that the deactivation due to such β-substituents would be more at the other β-position than at the γ-position (see I). Secondly, they assume that ethyl acetoacetate in presence of an electrophilic reagent such as a proton (obtained from sulphuric acid) may give rise to (II), but when a stronger reagent such as anhydrous aluminium chloride is used, the carbonium ion (III) may be formed. Hence, they contend that during Pechmann condensation with the above resorcinol derivatives in the presence of anhydrous aluminium chloride, the carbonium ion (III) will react in the less deactivated γ-position giving 5-hydroxycoumarin derivatives, but in presence of sulphuric acid, due to steric requirements, the attack by the entity (II), at the γ-position would be *inhibited* (probably the authors mean retarded), and substitution would, therefore, occur predominantly at the β-position giving 7-hydroxycoumarins.

The authors, however, have not explained how the entity (II) will react with the nuclear carbon atom. If one accepts the usual explanations put forward for electrophilic reactions,[2] either the entity (II) by the loss of a molecule of water should form the carbonium ion (III), or the carbonium ion (IV) would be formed if the proton attaches to the carbonyl oxygen of ethyl acetoacetate. One of these two entities (III or IV) would then attack the nuclear carbon. The formation of one entity in the presence of sulphuric acid and another in the presence of aluminium chloride may be reasonable; but it is difficult to prove or disprove any explanation put forward on the basis of the geometry of these entities. However, the explanation advanced by these workers on the basis of the formation of entity (II) does not appear to be plausible.



Further, it is difficult to understand the logic of the argument by which they explain the difference in the reactivity of the β- and γ-positions. Even if one assumes the conclusions

arrived at by them to be correct, then during such electrophilic substitution reactions as nitration, bromination, etc., the above compounds should furnish γ-substituted products; while actually during nitration or bromination of resacetophenone[3] or methyl β-resorcylate,[4] β-substituted products are obtained. On the other hand, on Gattermann formylation[5] or Friedel Crafts acylations[6] in presence of anhydrous aluminium chloride, the substitution occurs predominantly, if not exclusively, in the γ-position. One has also to consider the observation of Baker[7] that in resacetophenone derivatives, during Claisen and Fries rearrangements, the migration occurs preferentially to the γ-position when chelation exists but to the β-position if chelation is prevented, by masking the *ortho*-hydroxy group, and no trace of γ-isomer is reported. If as suggested by the authors, the degree of deactivation due to the electron-attracting groups, was the deciding factor in directing the substituents, the formation of β-isomers in the above cases becomes inexplicable. Hence this explanation is also not satisfactory.

The most important fact to be considered, before forwarding any explanation for this behaviour, is that in all the reactions studied, a free hydroxyl *ortho* to any chelate-forming group is an essential condition for γ-substitution; if the hydroxyl is masked, substitution occurs in the β-position. In view of this the earlier explanation of Baker,[7] Shah and their co-workers[8] that the γ-reactivity shown by these resorcinol derivatives is due to the existence of chelation (hydrogen bond formation) appears to be more plausible (though, as is now well known, the belief that chelation leads to absolute fixation of double bonds is erroneous[9]). Presumably, in the presence of protons the intramolecular hydrogen bond formation is weakened and during nitration and bromination the substitution occurs in the β-position, as generally in the case with other resorcinol derivatives. Strong chelate bonds are known to exist in the case of aluminium chloride (see V) and when such reagents are used, the substitution occurs predominantly in the γ-position.[10] It is suggested that the combined contributions of structures B and C to the resonance hybrid, i.e., by those having a double bond between the positions 1 and 2, becomes larger, than that of structures such as A (see VI). This would result in comparative greater electron density at the γ-position and hence the substitution in that position.[11]

The author is thankful to Dr. A. M. Mehta for helpful comments.

Organic Chemistry Labs., V. M. THAKOR.
The Inst. of Sci., Bombay,
October 28, 1952.

1. Bafna, S. L., and Shah, H. A., *Curr. Sci.*, 1952, **21**, 185. 2. *cf.* Alexander, E. R., *Principles of Ionic, Organic Reactions*, 1950, John Wiley & Sons. 3. Baker, *J. Chem. Soc.*, 1934, 1691; Desai and Ekhlas, *Proc. Ind. Acad. Sci.*, 1938, **8 A**, 576. 4. Hemmelmeyr, *Monatsch*, 1905, **26**, 185; Parekh and Shah, R. C. *J. Univ. Bombay*, 1942, **11**, 101. 5. Shah, R. C., *et al.*, *J. Chem. Soc.*, 1938, 1828; 1939, 132, 300, 949; 1940, 245; *Proc. Ind. Acad. Sci.*, 1949, **29 A**, 227. 6. Desai *et al.*, *Ibid.*, 1938, **8 A**, 194; 1940, **12 A**, 46, 394; Trivedi and Sethna, *J. Ind. Chem. Soc.*, 1951, **28**, 245; 1952, **29**, 141; Naik, Thakor and Shah, R. C., unpublished work. 7. Baker *et al.*, *J. Chem. Soc.*, 1934, 1684; 1935, 628; 1936, 274; *Ann. Repts. Chem. Soc.*, 1936, **33**, 279. 8. Shah, R. C., *et al.*, *J. Chem. Soc.*, 1938, 228, *et seq.* 9. —, *Presidential Address, Chem. Div. 38th Indian Science Congress*, 1951. 10. *cf.* Thomas, C. A., *Anhydrous Aluminium Chloride in Organic Chemistry*, 1941, Reinhold Publishing Corporation; Mellan, *Organic Reagents in Inorganic Analysis*, 1941, The Blackiston Company. 11. *cf.* Sidgwick, *Ann. Repts. Chem. Soc.*, 1933, **30**, 113; 1934, **31**, 41; Hunter, *Ibid.*, 1946, **43**, 148.

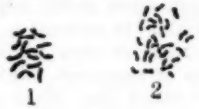
A PRELIMINARY REPORT ON THE COLCHICINE-INDUCED TETRAPLOIDS OF *ANONA SQUAMOSA* L.*[1]

THE fact that the autopolyploid fruits may attain larger size with an increase in the amount of flesh and that the number of seeds in them may be smaller,[5] induced the author to embark on the induction of polyploidy in *Anona squamosa* L., in October, 1950.

Since there is a dispute about the diploid chromosome number of *Anona squamosa*, its somatic chromosome number was determined from a large number of root-tip cells. to be 14 and not 16 as reported by Bowden[1] (Fig. 1). Chromosome counts in the pollen-mother-cells which showed 7 clear bivalents in side view metaphase I and 2 groups of 7 chromosomes in metaphase II, confirmed the above observation. Further confirmation was obtained from the count of chromosomes of affected colchicined seedlings which showed 28 chromosomes and not 32 which should be expected if Bowden's report was correct. This observation is also in agreement with that of Kumar and Randive[3] who reported the diploid chromosome number of *A. squamosa* to be 14 and not 16.

The author raised tetraploid *A. squamosa*, by colchicine treatment, a brief description of which is given below:

Seed Treatment: Seeds were germinated and treated with aqueous solution of colchicine on moist filter-papers placed in petri dishes. By a large number of trials it was found out that the seedlings on which the radicles had just emerged and in which the plumules were still inside the seeds responded most effectively to the action of colchicine. A large number of trials was then made with these seedlings which were completely immersed in aqueous solution of colchicine of various concentrations from 0·2 per cent. to 0·025 per cent. for various lengths of time from one hour to forty-eight hours. Polyploidy was successfully induced in those seedlings which were kept immersed in 0·2 per cent. for seven hours at 28° C.



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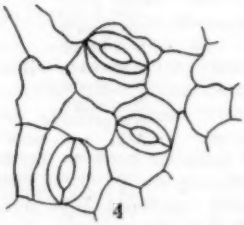

4

FIG. 1. Polar view of metaphase of mitosis showing 14 chromosomes in a root-tip cell, × 1,550.

FIG. 2. Somatic chromosomes from a root-tip cell of tetraploid *A. squamosa*, × 600.

FIGS. 3 and 4. Stomata of control and tetraploid plants, × 280.

Chromosome counts in the root-tip cells showed 28 chromosomes (Fig. 2) in most of the cells. The seedlings which were removed to pots after the treatment, showed extremely stunted growth, accompanied by malformed leaves, in the first phase of their development. However, after a period of four to five weeks they recovered and have been growing quite healthy (in the Botanical Garden, University of Dacca). The leaves of the tetraploids were found to be darker green in colour, thicker in texture, larger in size than the control.

FIG. 5. A twenty-month old plant with a young fruit in sight, × 1/20 Natural size.

Some of these colchicined plants were seen to flower in last May, i.e., 1952, in twenty months' time and produce a few fruits (Fig. 5) while the control did not show any sign of blossom. Early flowering has also been recently reported in colchicine-induced tetraploid gooseberries (*Ribes nigrum*).[5]

Since the tetraploids, as a rule, show delayed flowering[2] than the diploids, this observation that reproduction is hastened in the colchicine-induced tetraploids of a woody species is of considerable interest and the possibility that other woody species may show the same effect is worth closer inspection.

Shoot-tip Treatment: Seeds were sown in the soil and when the shoots were seen to emerge out just above the soil, the tips were plunged into small vials containing different concentrations of colchicine from 0·2 per cent. to 0·025 per cent. for various lengths of time, from one hour to seven days. Out of a large number of treatments colchicine produced appreciable effects only on a few seedlings which were subjected to six hours' treatment in 0·2 per cent. while the rest of the seedlings either succumbed to the effect of colchicine or were unaffected by the treatment.

In three of the colchicine-affected plants, the leaves were found to be darker green in colour, thicker in texture and larger in size with thicker midribs and veins than the control. These external features which are usually the external signs of polyploidy[4] led the author to believe that the above three plants were polyploids and an examination on the size of their stomata

(*cf.* Figs. 3 & 4), their frequency (see Table I) and the average size of the internal tissue of their leaves substantiated the belief that these plants had undergone polyploidy. (As the roots were not treated with colchicine chromosome counts from root-tip cells would not serve to indicate polyploidy).

In one colchicine-affected plant, a polyploid chimæra arose. It was interesting to note that the size of the polyploid leaves, in this case, was even smaller than those of the diploid branch, while in other characters, *e.g.*, texture, colour, stomatal frequency, etc., there was no difference between this chimerical plant and other normal polyploids. The growth-rate of the polyploids and the polyploid branch of the chimerical plant is slower than the control.

TABLE I

	Size of stomatal aperture	Size of guard cells	Number of stomata in the under-surface per sq. mm.
Treated	22·2–18·5 × 2·7– 1·8	39 –33·3 × 15·7–11·1	129
Control	14·8–11·1 × 1·8– 1·5	22·2–18·5 × 11·1– 9·25	303

The author acknowledges his gratefulness to Professor S. C. Harland, University of Manchester, for kindly going through the manuscript and kind criticism.

Dept. of Botany, A. S. ISLAM.
University of Manchester,
Manchester-13,
January 9, 1953.

* This piece of research work was carried out in the Dept. of Botany, University of Dacca, and partly financed by the Central Govt. of Pakistan.

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A MARINE SPECIES OF SLOW LACTOSE FERMENTING BACTERIUM

IN our studies on the bacterial flora of marine fish, we have come across a strain of slow lactose fermenter from mackerel caught off Tellicherry. Initial isolation was made on ZoBell's agar. This strain grows well on sea-water media but fails to grow on fresh-water media and in milk to which salt is not added. Thus it is typically a marine species. Even a one-year-old culture after sub-culturing half-a-dozen times, failed to grow in fresh-water media. If it were a terrigenous or fresh-water form, which had acclimatized itself to sea-water, it must survive when carried back to the fresh-water environment.[1] The strain described here, did not grow in fresh-water media and is essentially "marine" in origin. In contrast to this we have isolated two strains of slow lactose fermenters from the slime of mackerels, which grow well on fresh-water media also. Since a marine bacterium producing gas from lactose has not so far been described, a full description of our strain is given below :—

	DESCRIPTION
Sea-water agar colonies	Bluish grey, translucent, flat, entire
Sea-water agar slant	Translucent gray, smooth, becomes adherent and brittle later
Morphology	Rods, actively motile, small, single and pairs, 0·8×1·2 γ gram negative, nonspore-forming
Sea-water broth	Turbidity and thick cushion-like pellicle at top appearing like a layer of paraffin wax
Fresh-water broth	No growth
Gelatin	Not liquefied
Nitrates	Reduced to nitrites
Indole	Not produced
'Purple' milk	No change
H_2S	Not produced
Carbohydrates, etc.	Acid and small amount of gas from dextrose, sucrose, maltose and mannitol in 24 to 48 hours. No pellicle formed. Very slight acid formation and some gas from lactose in 9 days. Pellicle formed. Glycerol was not fermented but pellicle (growth) formed
Starch	Hydrolysed
Methyl Red	Positive; Voges Proskauer test, negative
Citrate	Not utilized. Urea; Not decomposed
V.R.B. agar	No growth
Fresh-water agar	No growth
Tolerates 10% NaCl.	

Source : Gills of mackerels, off Tellicherry.

Note.—All media except purple milk and fresh-water media, were made up with autoclaved sea-water,

According to Bergey's Manual[2] this may be classified as *Paracolobactrum coliformæ* but in view of its specific marine habitat, it may be designated as *P. coliformæ* var. *marinum*.

Further interest lies in the fact that *Paracolobactrum* species were isolated from cases of gastroenteritis.[3] We have described 9 strains of Paracolobactrum (under communication) from fresh-water fish, but the one described here differs from them. A full account of the types of bacteria in marine fish will be published elsewhere.

Our thanks are due to the Director of Fisheries, Madras, for permission to publish this note.

Fisheries Tech. Station, Kozhikode-1, *January* 2, 1953.
R. VENKATARAMAN.
A. SREENIVASAN.

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A TECHNIQUE FOR MASS-BREEDING OF *APANTELES* N. SP. (BRACONIDAE HYMENOPTERA)

Apanteles n. sp. is an internal larval parasite of the pink boll-worm, *Platyedra* (*Pectinophora*) *gossypiella* Saunders on cotton, and appears to be a very efficient and potential parasite of the pink boll-worm in the important cotton-growing tracts of India. The adults were at first collected from the environs of New Delhi by one of the authors (G. W. A.) and subsequently recovered from the following places: Delhi, Karnal, Ludhiana, Hansi, Bulandshahr, Kanpur, Raya, Nagpur, Akola, Jalgaon, Yeothmal, Surat and Coimbatore.

The technique of mass-breeding this parasite has been worked out in the parasite laboratory of the Division of Entomology, Indian Agricultural Research Institute, New Delhi. Eggs of *Corcyra cephalonica* Stainton were scattered over a disk of moist absorbent paper and exposed to the parasites in a cloth-covered glass cage (Fig. 1), the floor of which was covered

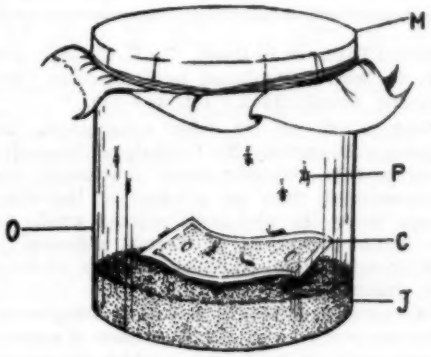

FIG. 1

O : Oviposition cages, P : Adult parasites, C : *Corcyra cephalonica* eggs pasted on the card, J : Crushed jowar, M : Muslin covering.

by a thin layer (about ½" in height) of crushed jowar. The parasites were fed on honey-sugar mixture and the oviposition cage left undisturbed for about 8 days after which the jowar containing the parasitised host larvæ transferred to a petri-dish. Adult parasites emerge from this culture about 20 days after oviposition. Only one cocoon has been observed on one host. Sex-ratio appears to be approximately 2 : 1 females predominating. The entire breeding was conducted at 25° C. and 75% R.H. Detailed studies as regards biology and field behaviour are in progress.

The success that has attended our efforts in breeding this new parasite on a mass scale on an easily available laboratory host augurs well for the biological control of a very serious cosmopolitan pest of cotton distributed throughout the cotton-growing regions of the world.

Division of Entomology, Indian Agri. Res. Inst., New Delhi, *January* 10, 1953.
E. S. NARAYANAN.
G. W. ANGALET.
B. R. SUBBA RAO.
G. I. D'SOUZA.

I.C.A.R. GRANT TO *CURRENT SCIENCE*

ON behalf of the CURRENT SCIENCE ASSOCIATION we acknowledge with thanks the renewal of a subsidy of Rs. 2,000 for the year 1952-53 granted by the Indian Council of Agricultural Research towards the cost of printing *Current Science*.

A. V. TELANG,
Secretary,
Current Science Association.

REVIEWS

Thermal Diffusion in Gases. By K. E. Grew and T. L. Ibbs. (Published by Cambridge University Press), 1952. Pp. xi + 143.

This is one of the latest monographs on physics, published by the Cambridge University Press and is decidedly more substantial and comprehensive than the volumes of the older series. Being the first book devoted wholly to the important subject of thermal diffusion, it will be widely welcomed by research workers and students alike.

Ever since the discovery of thermal diffusion by Chapman and Enskog, a large volume of experimental work has been done in which the contribution of the authors—Dr. Ibbs and Dr. Grew has been considerable. The authors have the pleasant task of presenting their own contribution along with those of others, which they have succeeded in doing with great clarity and insight in this small monograph. The first two chapters conveniently summarize the theory of thermal diffusion based closely on that given by Chapman and Cowling in 'The Mathematical Theory of Non-Uniform Gases', the aim being to familiarize the reader with the physical ideas rather than the complicated mathematical theory. The next two chapters give an account of the experimental methods and results obtained thereby. An attempt to correlate these results with theory has been done in Chapter V. The closing chapters of the book deal with the diffusion thermo-effect and the thermal diffusion in liquids.

The principal aim of the authors is to present the experimental work on thermal diffusion of which the major portion has been carried out during the last decade. The authors have succeeded in giving a clear and coherent account of the various experimental methods, the experimental results and the interpretation of these results in terms of the theory, and the molecular force models. The book is essentially written for the experimenter and will be extremely valuable to those embarking upon a course of experimental research in this field, as well as to non-specialists. The research worker must, however, supplement it by a much greater knowledge of the rigorous mathematical theory to be found in Chapman and Cowling's book. The reviewer feels that the value of the book would be enhanced by a more detailed account of the mathematical theory and by giving a treatment of thermal diffusion from the standpoint of the thermo-dynamics of irreversible processes.

The utility of the book has been greatly increased by the large number of references and by the exhaustive compilation of the experimental data on thermal diffusion, given at the end. Considering the book as a whole, the reviewer has no hesitation in recommending it to all those who want to study the subject for the first time, and, especially to those interested in the practical applications of thermal diffusion.

B. N. S.

Designing by Photo-Elasticity. By R. B. Heywood. (Chapman & Hall Ltd., London), 1952. Pp. 414. Figs. 65 S.

Dr. Heywood's book fills a long-felt gap in the field of designing and should be read by all connected with the fields of photo-elasticity and design. The science of stress analysis is being increasingly applied to the problem of designing parts which are light and yet of sufficient strength. This book draws attention to the elegant method of stress analysis by photo-elasticity and its application to the problems of design.

The first part of the book represents an excellent summary of the theory of photo-elasticity and takes up the following topics.

Chapter 1.—Behaviour of Light in Polariscope. This lays the basic foundations of photo-elasticity by dealing with the principles and the set-up of polariscopes. In particular, it contains a short description of the diffuse light polariscope, its merits and demerits. Chapter 2.—Photo-elastic Materials, and Chapter 3.—Models, Their Preparation and Testing. Photo-elastic materials, their properties, the methods of making and loading the model are dealt with in a concise and yet clear manner. Chapter 4.—Model Stresses Applied to Prototypes. Chapter 5.—Frozen Stress Technique for Three-Dimensional Analysis. This chapter describes the freezing technique employed in the three-dimensional analysis, slicing of the model and the examination of the slice and interpretation of the frozen stress pattern by the double slice and the oblique incidence methods. Materials suitable for the three-dimensional analysis and their properties and the application of the frozen

stress technique for specific problems are also dealt with.

The second part of the book deals at length with "Stress Concentration", the factor of increasing importance in the problems of design. Stress concentration factors potentially useful for direct application to design problems have been collected and are presented in a form convenient for ready reference.

Chapters 6, 7 and 8 present an excellent and up-to-date collection of data on the stress concentration factors in particular notches, screw threads, bolts and nuts and at holes for different types of structural numbers.

Chapter 9.—Improvement of Designs. This represents an inquiry into the methods by which the design of a part may be improved and gives an interesting exposition of the proper design of fillet shapes and their effects on the design of parts.

Chapter 10.—The Application of Stress Concentration Factors.

An extensive list of references classified according to the subject is given and will be found very useful by readers.

C. N. LAKSHMINARAYANA.

Solvents. By T. H. Durrans. 6th Edition. (Chapman & Hall), 1950. Price 21 *sh.*

This is the sixth edition of a well-known work. The subject is dealt in two parts, the first one dealing with fundamental aspects while the second part deals with individual members. Though the title leads one to expect a comprehensive account, the treatment is confined purely to solvents of use in the lacquer industry. The theoretical treatment is of the most general kind which is inadequate in a specialised monograph. The second and larger part contains a good deal of useful information on the characteristics of the different organic solvents divided according to their characteristic functional groups. The chapters on inflammability of solvents and their toxicity should prove useful to those handling these organic chemicals. The two appendices increases the value of the volume and the price is moderate. The volume can be recommended both to workers in the lacquer industry and to the general laboratory.

Superconductivity. By D. Shoenberg. 2nd Edition. (Cambridge Monographs on Physics, University Press), 1952. Pp. 256. Price 30 *sh.*

This book is an enlarged edition of Shoenberg's *Superconductivity* which appeared as one of the Cambridge Physical Tracts in 1938. The publication of the present volume is to be welcomed in view of the many recent advances in our "knowledge of the facts of superconductivity and in our understanding them" and also due to the lack of any other up-to-date account of the subject.

Although there have been many theoretical advances in the explanation of the behaviour of superconductors, the basic ideas necessary for putting forward a complete theory of the phenomenon have not all been clearly understood. This fact has, in the past, stimulated a variety of investigations conducted with a view to throw light on the nature of superconductivity. Professor Shoenberg has succeeded admirably in the task of making a comprehensive and ordered survey of these against the appropriate theoretical background. After a short introductory chapter, the author describes in detail the magnetic and thermodynamic properties of superconductors. Sections on thermal conductivity and thermo-electricity, not contained in the earlier edition, are introduced here. Chapters IV and V contain an account of our knowledge of the intermediate state and of the various methods by which the depth of penetration of a magnetic field in superconductors is investigated. The phenomenological theories of superconductivity and some recent attempts to put forward a more fundamental theory are described in the last chapter. Tables of numerical data are appended to the text. The extensive bibliography at the end of the book contains reference to more than 400 publications and includes the most recent work on the subject.

The author of the book has been actively engaged on research in this field or on allied fields of study for the last eighteen years. For about ten years he has also been the Director of the Royal Society Mond Laboratory at Cambridge, U.K., which is at present one of the leading centres for low temperature research. The book is, therefore, to be warmly recommended to all advanced students of physics—needless to mention that it will prove to be an indispensable guide to the research workers.

K. G. RAMANATHAN.

Pre-Stressed Concrete. By Kurt Billig. (McMillan & Co., Ltd., London, W.C. 2), 1953. Pp. x + 470. Price 36 *sh.* net.

Pre-stressed concrete is a recent off-shoot of reinforced concrete, which is highly elastic, has a small dead weight, and saves up to 85 per cent. in the weight of steel as compared with reinforced concrete.

There are very few text-books on this subject though many articles pertaining to it have appeared during the last five years in Civil Engineering magazines. In India, pre-stressed work started only two years back. The publication of this book, which gives in concentrated form all the information available on the subject is, therefore, very timely. Engineers specialising in reinforced concrete construction have to familiarise themselves with this newer form of construction as this will quickly supersede the older methods. They will find this book very useful.

The book is in three parts: the first deals with general data and fundamentals; the second, with the design of pre-stressed concrete structures; and the third one with design problems and includes a number of numerical examples.

The author has also proposed a draft code of practice which has been given in the end as an Appendix.

A recent development which seems to offer considerable attractiveness is the possibility of using bars instead of wires. Ultimately, the choice among the various kinds of reinforcement and the several methods of fabrication will be based on simplicity of construction methods and cost.

The following topics could have been further elucidated or included in the book to make it more exhaustive. The fatigue strength of pre-stressed concrete appears to be almost entirely related to the bond strength under repeated loading and the strength of the anchorage under such loading. This anchoring of the ends of reinforcement inevitably produces stress concentrations. Tests of the adequacy of anchorages will have to be made where it is proposed to depend entirely on the anchorages to develop the stress in the reinforcement. The fire resistance of pre-stressed concrete depends both on the loss due to changes in length and changes in physical properties caused to the wires. A secondary factor should also be considered, which is the possible change in the strength of the anchorage as it is heated. Design of pre-stressed reinforcement in structures subjected to reversal of loading may be included in the third part. So also the problem which arises when a structure is subjected to blast deserves close study. The problem of designing pre-stressed concrete for continuity has been discussed thoroughly by the author.

The draft code suggested by the author should prove useful to the Joint Committee of the American Society of Civil Engineers and the American Concrete Institute recently constituted to draw up a general specification. The addition of an index to the book would have added to its usefulness. N. S. GOVINDA RAO.

Ink and Paper in the Printing Process. By Andries Voet. (Published by Interscience Publishers, Inc., New York), 1952. Pp. xii + 213. Price $ 5.90.

The volume under review is essentially an introduction to the physics and chemistry of printing ink and its reaction with paper. Probably this is the only book of its kind in which an attempt has been made to present the subject in proper scientific perspective. While it is primarily intended for "the more experienced graphic art student with basic understanding of science", one feels that the book may be read with interest and profit by any student of physical science, inasmuch as it covers a field in which the basic principles of physics and chemistry find such fruitful application.

Such topics as colour, gloss and dispersion of ink, on which standard treatises are available, have been rightly omitted from the purview of this volume. It is divided into two sections entitled "Ink and Press", and "Ink and Paper", which are again subdivided into sixteen short chapters.

Some of the earlier chapters in Part I deal exclusively with such basic topics as viscosity, flow of dispersions, thixotropy, etc. The remaining chapters contain a discussion of the flow characteristics of ink and the separation of ink films. The use of specialised types of instruments like the inkometer, tackmeter, spreadometer, etc., is fully described with adequate theoretical background.

The second part is devoted to various topics such as the characteristics of discontinuous reproduction, halftone printing, contrast and coverage of ink, uniformity of ink films, penetration of ink into paper, ink transfer and such printing defects as "print through" "pricking of paper" and offset. The two well written chapters on physical and chemical drying of ink deal exhaustively with a subject of wide interest to many branches of technology.

A. P. MADHAVAN NAIR.

Annual Review of Biochemistry. Vol. 21. (Publisher: Annual Reviews, Inc., Stanford), 1952. Pp. 781. Price $ 6.00.

With the publication of this volume, the twenty-first in the series, the *Annual Review of Biochemistry* may be said to have come of age, although the reputation for its excellence was well established a long time ago. In spite of

the fact that new Annual Reviews have been published in recent years, in closely related fields, some of which have absorbed a considerable portion of the subject-matter of biochemistry in its broadest sense, the present volume is over 750 pages of small print and has not diminished either in size or in wealth of material. The volume consists of twenty-three articles written by scientists, who can claim eminence in their respective fields of biochemical investigation. Even though some of the articles are disproportionately long, they have been written in such an elegant and comprehensive manner that they deserve very careful study.

As in previous numbers, the articles on proteolytic enzymes, non-oxidative, non-proteolytic enzymes and biological oxidations have been presented in this volume in the very beginning, and they cover very well the researches carried out during the year under review. The topics on the chemistry of various classes of substances such as carbohydrates, carotenoids, lipids, steroids, non-steroids, hormones, amino acids, nucleic acids, with a special article on the chemistry of muscle, have been presented next. Similarly, the research work carried out on the metabolism of the above-named substances have also been reviewed in subsequent articles. There are, further, three topics on fat-soluble vitamins, water-soluble vitamins and general nutrition respectively. The reviews on chromatography and on comparative biochemistry, as well as on the biochemistry of neoplastic tissue and antibiotics, may be considered in the nature of special articles, as they deal with the rapid advances which have taken place in these particular fields during the year under review.

There can be no doubt that all the articles constitute a judicious appraisal of the year's research work in all the different branches of biochemistry and nutrition. They have all been written as critically and, at the same time, as comprehensively as possible. The present volume of the *Annual Review* has maintained the high standard of the earlier volumes of this series and should prove indispensable to all those who are interested both in the research and the teaching of biochemistry and nutrition.

P. S. SARMA.

Proceedings of the Symposium on Indian Oils and Fats and Their Utilization. (National Chemical Laboratory of India). Price Re. 1.

This is a record of the discussion of the various problems for a fuller utilization of the oil and fat resources of the country. The discussions were held under the following major heads, the figures under brackets showing the number of papers read under each head: (*a*) oilseeds and vegetable oils (11); (*b*) oil extractions (9); (*c*) soap and glycerine (5); (*d*) hydrogenation of oils (4); (*e*) fish oils (1); (*f*) castor oil, drying oils, paints and varnishes (9); (*g*) analytical and other miscellaneous papers (11). It is thus seen that all aspects of the problem have been considered. A perusal of the publication shows that those who contributed papers and those who took part in the discussions, have given considerable thought to the subjects and, as a result, one is able to gain an authoritative and authentic picture.

There are many trees in Indian forests whose full economic utilization to supplement the oilseed supply is a matter of great urgency. The first paper deals with the forest oilseed wealth of Bombay State. The refining and utilization of the natural resources are adequately dealt with. Problems relating to oil extraction, hydrogenation of oil, soap manufacture and shark liver oil industry have also been well discussed. The last section deals with various analytical methods. The publication deserves earnest perusal by all persons who are interested in the industries relating to fats and oils.

K. N. M.

Practical Plant Pathology. By M. N. Kamat. (Prakash Publishing House, Poona), 1953. Pp. xiii + 200. Price not given.

The author has undertaken a commendable task in bringing out a book on practical plant pathology to meet the requirements of students in Agricultural Colleges and University Laboratories in India. The plan of the book is well laid out and the get-up is good. Numerous plates have been provided to help the student in his studies.

It appears that proof-reading has not been carried out properly as is evidenced by numerous spelling mistakes. The legends and figures in some plates are also not correct (*e.g.*, Plate 33, Fig. 6; Plate 36, Fig. 11).

There are several factual inaccuracies which should have been avoided, *e.g.*, page 33, item 27: "withertip" is given as an example of canker; page 55: downy mildews are described as "typically aquatic"; page 79: smuts and bunts are stated to be "facultative parasites"; page 81: infection type of long smut of sorghum is mentioned as "unknown"—this has been described by different authors; page 44: late blight of potatoes is stated to be destructive "on the Nilgiris", whereas this disease is unknown

there; page 135: the heading is given as *mycelia sterila* but included in it are *Polyporus*, etc.

In the chapter on principles of plant disease control, the measures advocated are not the best in several instances. This chapter is in need of thorough revision.

On going through the book, one is left with the impression that it has been prepared in haste, without strict verification of the statements made. The author would do well to revise the book and bring out a corrected edition. T. S. R.

Books Received

Applied Electricity. By H. Cotton. 2nd Edition. (Cleaver Hume Press Ltd.), 1953. Pp. xii + 482. Price 18 *sh.* 6 *d.*

The Wealth of India. Edited by B. N. Sastri. (C. S. I. R. Publications Division), 1953. Pp. xx + 236 + xxix. Price Rs. 18.

Crime Investigation. By Paul L. Kirk. (Interscience Publishers, N.Y.), 1953. Pp. 808. Price $ 10.00.

The Chemistry and Physiology of the Nucleus. Edited by V. T. Bowen. (Academic Press, Inc.), 1952. Pp. ix + 402. Price $ 7.00.

Signal, Noise and Resolution in Nuclear Counter Amplifiers. By A. B. Gillespie. (Pergoman Press, Ltd.), 1953. Pp. ix + 155. Price 21 *sh.*

The Elements of Nuclear Reactor Theory. By Samuel Glasstone and Milton C. Edlund. (MacMillan & Co.), 1953. Pp. 416. Price 35 *sh.*

Dissociation Energies and Spectra of Diatomic Molecules. By A. G. Gaydon. 2nd Edition. (Chapman & Hall), 1953. Pp. xiii + 261. Price 35 *sh.* net.

Ferrous Analysis (Modern Practice & Theory). By E. C. Pigott. 2nd Edition. (Chapman & Hall), 1953. Pp. xxvii + 690. Price 84 *sh.* net.

BCG Vaccination. (World Health Organization), 1953. Pp. 307. Price $ 3.00.

The Comets and Their Origin. By R. A. Lyttleton. (Cambridge University Press), 1953. Pp. 173. Price 25 *sh.*

Die-Gasturbine. By Von J. Kruschik. (Wien Springer Verlag), 1952. Pp. xi + 469. Price $ 15.00.

Radiations and Living Cells. By F. G. Spear (Chapman & Hall), 1953. Pp. xii + 222. Price 18 *sh.* net.

Historical Metrology. By A. E. Berriman. (London J. M. Dent & Sons. Ltd., New York, E. P. Dutton & Co.), 1953. Pp. xv + 224. Price 16 *sh.*

SCIENCE NOTES AND NEWS

Endeavour Prizes

The Imperial Chemical Industries, Limited, Publishers of the scientific review, *Endeavour*, have offered the sum of 100 guineas to be awarded as prizes for essays submitted on the following subjects: Radio-Astronomy; Colour and Chemistry; Biology in World Affairs; Science and Safety in Transport; Science and Art; Scientific Contributions to Medicine; Scientific Societies and Their Role; Power and Civilization. The competition is restricted to those who are under 25 years of age on 1st June 1953.

The essays, which must be in English and typewritten, should not exceed 4,000 words in length and only one entry is permitted from each competitor. In judging the results, special attention will be paid to the originality of approach to the subject, and great importance will be attached to literary style.

Entries should reach the Assistant Secretary, British Association for the Advancement of Science, Burlington House, Piccadilly, London, W.1, before 1st June 1953.

New Issue of _British Pharmacopoeia_

The first edition of the *British Pharmacopœia* appeared in 1864 under a Section of the Medical Act, 1858, which provided for the original publication and periodical re-publication. On 2nd March 1953, appeared the eighth *British Pharmacopœia*, now under the official sanction of the Medical Act, 1950, and for the first time published by the Pharmaceutical Press on behalf of the General Medical Council (Price 50 *sh.*)

The *British Pharmacopœia*, 1953, is a complete revision. Each drug is discussed in a monograph covering such matters as chemical formula, description, solubility, methods of identification, assay and dosage in the various preparations available. For the first time, Latin

has been abandoned in the main title of the monographs (nearly 750 in all) and English is used with Latin as a sub-title. Doses are expressed in the metric system only, except for those substances and preparations commonly used or prescribed in the Imperial system. A series of 25 appendices describes standards for materials used in official tests, and descriptions of chemical, physiological and biological assay procedures. The new *British Pharmacopœia* becomes official from September 1, 1953.

Twenty-Sixth International Congress of Industrial Chemistry

The Twenty-sixth International Congress of Industrial Chemistry will be held in Paris during 21st to 27th June 1953. Sectional meetings will be held on Chemical Analysis; Minerals; Ceramics; Resin; Rubber; Cellulose; Paper; and Textiles, etc. Further details can be had from the Secretary, XXVI Congress International De Chimie Industrielle, 28, rue Saint-Dominique, Paris VII.

Sixth International Congress of Microbiology

The Sixth International Congress of Microbiology will be held in Rome during September 6th to 12th of this year. In addition to plenary sessions and meetings under the various sections, symposia on the following subjects have been planned to be held: Bacterial Cytology; Microbial Metabolism; Nutrition and Growth Factors; Growth Inhibitors and Chemotherapy; Morphology, Biology and Systematics of the Actinomycetales; and Host-Virus Interactions. For fuller particulars, please write to: G. Sanarelli, Segreteria del Congresso, Istituto di Igiene, Citta Universitaria, Rome, Italy.

Antibiotics from Soil, Plants and Other Sources

A symposium on "Anti-Bacterial Substances from Soil, Plants and Other Sources", was held on 26th and 27th March 1953 in Bombay under the auspices of the Pharmaceuticals and Drugs Committee of the Council of Scientific and Industrial Research. In the absence of Col. R. N. Chopra, Chairman of the Committee, Dr. B. Mukerji, Director, Central Drug Research Institute and Member of the Pharmaceuticals and Drugs Committee, presided.

Twenty-one papers dealing with the isolation, testing, standardization, therapeutic uses and mode of action of anti-bacterial substances from various sources were presented at the symposium. It is proposed to publish the proceedings of the symposium in the form of a brochure consisting of abstracts of various papers and discussions thereon.

Effects of Tannage on the Properties of Leather

Specific information regarding the effects of different tannage on the properties of leather has recently been obtained by Dr. J. R. Kanagy and associates of the National Bureau of Standards, U.S.A. Leathers tanned with chrome alone were compared with those tanned first with chrome and then re-tanned with vegetable tannins. The results in genreal indicate that each of the two types of leather has certain definite advantages, and that choice of tannage should depend largely on the properties desired in the finished leather.

Both methods of tanning are widely employed in the leather industry. In general, the more rapid chrome-tanning is now chiefly used for lighter leathers, such as calfskin shoe uppers and kidskins for gloves, while the two-step process is used for heavier leathers such as soles, belting and heavy uppers.

The test results showed that the vegetable tannins tend to decrease water resistance, reduce strength and increase thickness. However, on the whole, the properties produced by use of the vegetable tannins tend to make the leather more comfortable for shoes and to increase cutting value (percentage of useable hide).

Calorie and Body-Weight

Between 1943 and 1949, the Ministry of Food, U.K., regularly made large-scale investigations of the calorie value of food reaching the consumer and the changes in average body-weight. Subjects of the investigations were housewives and men and women employed in light industries. Every year, 3,000 to 4,500 people were put on the scales and 20,000 to 30,000 furnished information about food eaten and the state of larder stocks.

Graphs plotted from this information showed a striking resemblance. During the last two years of the war, there was an increase of about 140 calories per head per day in the foods consumed, and men put on about 1½ lb. in weight, women 3 lb. In the first two post-war years, the daily calorie intake fell by 120 and men lost 1 lb., women ½ lb.; from 1947 to 1949 the energy value of the diet rose by 120 calories and men's body weight rose by 2 lb. and women's by 3 lb.

Commenting on the investigations, the Ministry of Food take the view that on certain broad assumptions, changes in body-weight can be taken as an index of the adequacy of food supplies and of the state of peoples' health.

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